HAND-BOOK

TO THE

LOCAL MARINE BOARD EXAMINATION,

FOR

THE OFFICERS

OF THE

BRITISH MERCANTILE MARINE;

INCLUDING THE

Regulations for Masters and Mates in the Coasting Trade,

A Diagram illustrating Current Sailing, and Directions for working the Tides;

WITH FULL AND COMPLETE ANSWERS TO

THE QUESTIONS IN STEAM.

TWENTIETH EDITION

Entered at Stationers Hall.

London:

PUBLISHED BY MRS. JANET TAYLOR,

AT HER NAUTICAL ACADEMY AND NAVIGATION WAREHOUSE.

104, MINORIES.

1860.

Price 3/-

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PREFACE.

THE very extensive and increasing demand for the "HAND-BOOK TO THE LOCAL MARINE BOARD EXAMINATION," (which has already passed through several Editions,) and the universal approval its general arrangements have received, have induced me, in preparing another edition, to add much new and valuable matter to its pages, to render it deserving the continued patronage of those desirous of making themselves thoroughly competent for passing the Local Marine Boards; and on examination of the work, it will be found to contain all those Questions and Exercises in Navigation and Steam, requisite in preparing for the different grades in the profession,—independent of Seamanship, a knowledge of which can only be acquired by service at sea.*

The Arithmetical Questions and Exercises in Logarithms, which have been introduced at the commencement,

* Mrs. Taylor has published a work on Seamanship, by Capt. Liddle, which contains all the required answers in Seamanship, in which great care has been taken not to overburden the memory by useless matter, but just give such brief information as will help the pupil to put his own ideas into fitting words. To the edition just published (July 1859,) have been added Questions and Answers on Seamanship for *Extra* Masters.

will be found useful, as preparatory to the Examples in Nautical Astronomy.

Part of the very useful paper with accompanying Diagrams, on the *Rule of the Road,* which was originally published in the *Mercantile Marine Magazine,* have been added to this work, the great necessity for a better knowledge of this important part of a seaman's duty, being obvious to all who take an interest in affairs connected with our Mercantile Marine, and the very simple directions there given, with diagrams illustrative of ships' positions, and best mode of manœuvring when placed in imminent danger, will be found of service in the every-day practice of the seaman's life.

To this Edition have been added directions, and a diagram, for working the questions in Current Sailing, by which the principle is fully demonstrated.

The method of finding the height of the water at any time of Tide, is likewise introduced and explained.

In the *Examination for Extra Masters* have been added,—

First, fully worked examples of the Latitude by Double Altitudes of the Sun, as verified by Sumner's method,—the *rule,* unassisted by calculation, presenting a difficulty to some, to whom the clear exposition of the rule thus given, will be found of great service.

Secondly, the Article on *"The Law of Storms,"* has been considerably enlarged, and much valuable information, accompanied by diagrams, introduced, a careful study of which will be of great advantage to those frequenting the Hurricane portions of the Ocean; every imaginable danger being met by brief directions, and carefully digested rules of action under existing difficulties.

In the Answers to the Questions in Navigation, it has been thought sufficient to give only the more prominent portions of the solutions, thereby leaving the student to do something for himself, by studying the Rules in the Epitome, and endeavouring to fully understand the use of Logarithms and other Tables. If properly and accurately worked out, the answers should not deviate in any case, more than 10″ or 12″ from those given at the end of the book, such difference arising from the Dip and Refraction Tables which the student may use. It cannot be too deeply impressed on all, that an accurate knowledge of *Time* is essentially requisite, without which, no question in Nautical Astronomy can be correctly solved.

It is necessary to state, that in all cases where the Moon's horizontal parallax is used, that element has been reduced for the latitude of the place of observation.

The instructions for Stowing Cargo, are those recommended by Lloyd's. In respect to Charter-party, Bills of Lading, Bottomry Bonds, &c. it has been the object merely

to give a general knowledge of the subjects, and to indicate what is required, for the entire description and requirements of such documents cannot be given in a work of this description, in such a manner as to make the young Master fully acquainted with them, as condensation of such matter frequently involves obscurity; and it is incumbent on every Master to understand thoroughly the Laws of Shipping, for which purpose, reference must be made to the Works of ABBOT, M'CULLOCH, STEEL, LEES, &c.

Appendix I, contains the Questions and Answers for the Examination in Steam. Although the answers are given very fully, the works indicated in p. 131, should be carefully perused, in order to obtain a better and sounder knowledge of the subject.

Appendix II, contains the Answers to the general Questions in Navigation, &c.

Appendix III, contains the Answers to the Questions in the Extra Examinations.

JANET TAYLOR.

NAUTICAL ACADEMY,

104, MINORIES, LONDON.

CONTENTS.

Extract from the Mercantile Marine Magazine,

"This book is intended as a Guide to the Officers of all grades of the Merchant Service, in the Examinations they are required to undergo, before the Local Marine Board. It does not profess to include Seamanship, which is a subject to which seamen generally devote more attention than to Navigation and Nautical Astronomy, forgetful that the latter branch of their profession is as essential as the former, if they desire to advance in life. So far as we have looked through the book, it seems judiciously arranged, and the different subjects carefully drawn up, and to the purpose; in fact, *without any pretensions, it is the best book of the kind that has yet been published.* A good method has been adopted in regard to the answers, (given at the end of the work,) whereby the student at sea can at once fix on that part of the solution, in which he may have committed an error, by which means he will be encouraged to progress, and to improve himself."

NOTICE

OF

EXAMINATIONS OF MASTERS AND MATES

OF

Foreign-going Ships and of Home Trade Passenger Ships,

Established in pursuance of the Mercantile Shipping Act, 1854;

AND OF

VOLUNTARY EXAMINATIONS IN STEAM.

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1. UNDER the provisions of the Merchant Shipping Act, 1854, (17 and 18 Vict. c. 104, ss. 136—161,) no Foreign-going Ship* or Home Trade Passenger Ship* can obtain a clearance or transire, or legally proceed to sea, from any port in the United Kingdom, unless the master thereof, and in the case of a Foreign-going Ship, the first and second mates or only mate, (as the case may be,) and in the case of a Home Trade Passenger Ship, the first or only mate, (as the case may be,) have obtained and possess valid Certificates, either of Competency or Service, appropriate to their several stations in such ship, or of a higher grade; and no such ship, if of *one hundred tons burden and upwards*, can legally proceed to sea unless at *least one officer, besides the master*, has obtained and possesses a valid Certificate, appropriate to the grade of only mate therein, or to a higher grade: and every person who, having been engaged to serve as

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* By a Foreign-going Ship is meant one which is bound to some place out of the United Kingdom, beyond the limits included between the rivers Elbe and Brest; and by a Home Trade Passenger Ship is meant any Home Trade Ship employed in carrying passengers; and it is to be observed that *Foreign Steam Ships when employed in carrying passengers between places in the United Kingdom*, are subject to all the provisions of the Act, as regards Certificates of masters and mates, to which British Steam Ships are subject. (s. 291.)

master, or as first or second or only mate of any Foreign-going Ship, or as master or first or only mate of a Home Trade Passenger Ship, goes to sea as such master or mate, without being at the time entitled to and possessed of such Certificate as the Act requires, or who employs any person as master, or first, second or only mate of any Foreign-going ship, or as master or first or only mate of any Home Trade Passenger ship, without ascertaining that he is at the time entitled to and possessed of such Certificate, *for each offence incurs a penalty not exceeding fifty pounds.*

2. [s. 137.] Every Certificate of *Competency* for a Foreign-going ship is to be deemed to be of a higher grade than the corresponding Certificate for a Home Trade Passenger ship, and entitles the lawful holder to go to sea in the corresponding grade in such last-mentioned ship; but *no Certificate for a Home Trade Passenger ship entitles the holder to go to sea as master or mate of a Foreign-going ship.*

3. [s. 135.] A Certificate of *Service* entitles an officer, who has already served as either master or mate in a British Foreign-going ship before the 1st January 1851, or as master or mate in a Home Trade Passenger Ship before the 1st January 1854, to serve in those capacities again; and it also entitles an officer who has attained or attains the rank of Lieutenant, Master, passed Mate or second Master, or any higher rank in the service of Her Majesty, or of the East India Company, to serve as master of a British Merchant ship, and may be had by application to the Registrar-General of Seamen, Custom-house, London, or to any Shipping Master in the Out-ports, on the transmission and verification of the necessary certificates and testimonials.

4. [s. 134.] Certificates of *Competency* will be granted to those persons who pass the requisite examinations, and otherwise comply with the requisite conditions. For this purpose Examiners have been appointed under the Local Marine

Boards, and arrangements have been made for holding the examinations at the under mentioned ports, upon the days specified against them; and these days are so arranged for general convenience, that a candidate wishing to proceed to sea, and missing the day at his own port, may proceed to any port where an examination is coming forward. The days for commencing the examinations at the various ports are as follow :—

PLACES.	DAYS.
**Aberdeen*	...Friday and Saturday in the first and third week in each Month.
Belfast	......First and third Tuesday in each Month.
**Bristol*	......First and third Tuesday in each Month
Cork	.........Fourth Monday in each Month.
Dublin	......First and third Thursday in each Month.
**Dundee*	......Saturday in each Week.
**Glasgow*	Thursdays, held alternately at each place.
**Greenock*......	
**Hull*	.........Second Tuesday in each Month.
**Leith*	.........Second Tuesday and third Saturday in each Month.
**Liverpool*	.....Monday, Tuesday, Thursday and Friday in each Week.
**London*	......Monday, Tuesday, and Wednesday, in Navigation Thursday, Friday, and Saturday, in Seamanship.
**Newcastle*	.....First day in each Month not being Sunday.
**Plymouth*	.....First and third Wednesday in each Month.
**Shields*	........Tenth day of each Month not being Sunday.
**Sunderland*	...Twentieth day of each Month not being Sunday.

5. Applicants for examination must give their names to the Shipping Master, or to the Local Marine Board at the place where they intend to be examined, on or before the day of examination, and must conform to any regulations in this respect which may be laid down by the Local Marine Board; and if this be not done, delay may be occasioned.

* At these places Extra Examinations are held.

6. [s. 134.] Testimonials of character, and of sobriety, experience, ability, and good conduct on board ship, will be required of all applicants, and without producing them no person will be examined. As such testimonials may have to be forwarded to the office of the Registrar-General of Seamen in London for verification, before any certificates can be granted, it is desirable that candidates should lodge them as early as possible. Upon application to the Shipping Master, candidates will be supplied with a form, which they will be required to fill up and lodge with their testimonials in the hands of the Examiners.

7. The examinations will commence early in the forenoon on the days before mentioned, and be continued from day to day until all the candidates whose names appear upon the Shipping Master's list on the day of examination are examined.

8. [s. 131.] The qualifications required for the several ranks under mentioned, are as follow;

Qualifications for Certificates of Competency for a Foreign-going Ship.

(*a*.) **A SECOND MATE** must be seventeen years of age, and must have been four years at sea.

In Navigation.—He must write a legible hand, and understand the four first rules of arithmetic, and the use of logarithms. He must be able to correct the courses steered for variation and leeway, and find the difference of latitude and longitude therefrom; be able to correct the sun's declination for longitude, and find his latitude by meridian altitude of the sun; and work such other easy problems of a like nature as may be put to him. He must understand the use of the sextant, and be able to observe with it, and read off the arc.

In Seamanship.—He must give satisfactory answers as to the rigging and unrigging of ships, stowing of holds, &c.: must understand the measurement of the log line, glass, and lead-

line; be conversant with the rule of the road, as regards both steamers and sailing vessels, and the lights carried by them.

(*b.*) **An ONLY MATE** must be eighteen years of age, and have been four years at sea.

In Navigation.—In addition to the qualification required for a Second Mate, an only Mate must be able to work a day's work complete, including the bearing and distance of the port he is bound to, by Mercator's method. He must be able to observe, and calculate the amplitude of the sun, and deduce the variation of the compass therefrom. He must know how to lay off the place of the ship on the chart, both by bearings of known objects, and by latitude and longitude. He must be able to use a sextant and determine its error, and adjust it, and find the time of high water from the known time at full and change.

In Seamanship.—In addition to what is required by a Second Mate, he must know how to moor and unmoor, and to keep a clear anchor; to carry out an anchor; to stow a hold; and to make the requisite entries in the ship's log.

(*c.*) **A FIRST MATE** must be nineteen years of age, and have served five years at sea, of which one year must have been as either Second or Only Mate, or as both.*

In Navigation.—In addition to the qualification required for an Only Mate, he must be able to observe azimuths and compute the variation; to compare chronometers and keep their rates, and find the longitude by them from an observation of the sun; to work the latitude by single altitude of the sun, off the meridian; and be able to use and adjust the sextant by the sun.

In Seamanship.—In addition to the qualification required for an Only Mate, a more extensive knowledge of seamanship will be required, as to shifting large spars and sails, managing

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* Service in a superior capacity is in all cases to be equivalent to service in an inferior capacity.

a ship in stormy weather, taking in and making sail, shifting yards and masts, &c., and getting cargo in and out; and especially heavy spars and weights, anchors, &c.; casting ship on a lee shore: and securing the mast in the event of accident to the bowsprit.

(*d.*) **A MASTER** must be twenty-one years of age, and have been six years at sea, of which one year must have been as First or Only Mate, and one year as Second Mate, or two years as First and Only Mate.

In addition to the qualification for a First Mate, he must be able to find the latitude by a star, &c. He will be asked questions as to the nature of the attraction of the ship's iron upon the compass, and as to the method of determining it. He must possess a sufficient knowledge of what he is required to do by law, as to entry and discharge, and the management of his crew, as to penalties and entries to be made in the official log. He will be questioned as to his knowledge of invoices, charter-party, Lloyd's agent, and as to the nature of bottomry, and he must be acquainted with the leading lights of the channel he has been accustomed to navigate, or which he is going to use.

In cases where an applicant for a certificate as master ordinary has only served in a fore and aft rigged vessel, and is ignorant of the management of a square rigged vessel, he may obtain a certificate on which the words "*fore and aft rigged vessel,*" will be written. This is not however, to apply to mates, who being younger men, are expected for the future to learn their business completely.

(*e.*) **An EXTRA MASTER'S EXAMINATION** is intended for such persons as wish to prove their superior qualifications. Before being examined for an Extra Master's Certificate, an applicant must have served one year either as a Master with an *ordinary Certificate of Competency*, or as a Master having a *First Class Certificate*, granted by one of the former Boards of Examiners.

In Navigation.—As the vessels which such Masters will

command frequently make long voyages, to the East Indies, Pacific, &c. the candidate will be required to work a lunar observation by both sun and star, to determine the latitude by the moon and star, by Polar star off the meridian, and also by double altitude of the sun, and to verify the result by Sumner's method. He must be able to calculate the altitudes of the sun or star when they cannot be observed, for the purpose of lunars,—to find the error of a watch by the method of equal altitude,—and to correct the altitudes observed with an artificial horizon.

He must understand how to observe and apply the deviation of the compass, and to deduce the set and rate of the current from the D. R. and observation. He will be required to explain the nature of great circle sailing, and know how to apply practically that knowledge; but he will not be required to go into the calculations. He must be acquainted with the law of storms, so far as to know how he may probably best escape those tempests common to the East and West Indies, and known as hurricanes.

In Seamanship.—The extra examination will consist of an inquiry into the competency of the party to heave a ship down, in case of accident befalling her abroad; to get lower masts and other heavy weights in and out; how to construct rafts, and as to his resources for the preservation of the ship's crew in the event of wreck, and in such operations of a like nature, as the Examiner may consider necessary.*

Qualifications for Certificates of Competency for Home Trade Passenger Ships.

(*a.*) **A MATE** must write a legible hand, and understand the first four rules of arithmetic. He must know and understand the rule of the road, and describe and show that he understands the Admiralty regulations as to Lights. He must be able to

* The New Edition of "Seamanship," by Capt. Liddle, published by Mrs. Janet Taylor, contains full information on this subject, for those preparing for the Extra Examination.

take a bearing by compass, and prick off the ship's course on the chart. He must know the marks in the lead line, and be able to work and heave the log.

(*b.*) **A MASTER** must have served one year as a mate in the Foreign or Home Trade. In addition to the qualifications required for a mate, he must show that he is capable of navigating a ship along any coast, for which purpose he will be required to draw upon a chart produced by the Examiner, the courses and distances he would run along shore from headland to headland, and to give in writing the courses and distances corrected for variation, and the bearings of the head lands and lights, and when the courses should be altered, either to clear any dangers or to adapt it to the coast. He must understand how to make his soundings according to the state of the tide.

General Rules as to Examinations and Fees.

9. The candidates will be allowed to work out the various problems according to the method and the tables they have been accustomed to use, and will be allowed five hours to perform the work, at the expiration of which, if they have not finished, they will be declared to have failed, unless the Local Marine Board see fit to extend the time.

Fees to be paid by Applicants for Examination.

10. [s. 133.] The fee for examination must be paid to the Shipping Master. If a candidate fail in his examination, half the fee he has paid will be returned to him by the Shipping Master, on his producing a document which will be given him by the Examiner.

The fees are as follows:—

For Foreign-going Ships,

Second Mate	£1	0	0
First and Only Mate, if previously possessing an inferior certificate	0	10	0
If not	1	0	0
Master, whether Extra or Ordinary	2	0	0

For Home Trade Passenger Ships,

Mate	0	10	0
Master	1	0	0

11. Any one who has been one year in possession of a Master's first-class Certificate, granted by one of the former Boards of Examiners, or of any ordinary Master's Certificate of Competency granted under the present Examiners, may pass an Extra Examination, and receive an Extra Certificate in exchange for his former one, without payment of any fee; but if he fails in his first examination, he must pay half a Master's fee on his coming a second time; and the same sum for every subsequent attempt.

12. If the applicant passes, he will receive a document from the Examiner, which will entitle him to receive his Certificate of Competency from the Shipping Master at the port to which he has directed it to be forwarded. If his testimonials have been sent to the Registrar to be verified, they will be returned with his certificate.

13. If an applicant is examined for a higher rank and fails, but passes an examination of a lower grade, he may receive a Certificate accordingly, but no part of the fee will be returned.

14. In all cases of complete failure, the candidate must be re-examined *de novo*, and in case of failure in *Seamanship*, a candidate will not be re-examined *until after a lapse of* SIX MONTHS, to give him time to gain experience.

15. As the examinations of Masters and Mates are made compulsory, the qualifications have been kept as low as possible; but it must be distinctly understood, that it is the intention of the Board of Trade to raise the standard from time to time, whenever, as will no doubt be the case, the general attainments of officers in the merchant service, shall render it possible to do so without inconvenience: and officers are strongly

urged to employ their leisure hours, when in port, in the acquirement of the knowledge necessary to enable them to pass their examinations; and Masters will do well to permit apprentices and junior officers to attend schools of instruction, and to afford them as much time for this purpose as possible.

T. H. Farrer,
Secretary,
Marine Department, Board of Trade,
May, 1855.

N.B.—For notice respecting the "Examination in Steam," *see* Appendix 1.

APPROPRIATE CERTIFICATES.

A person possessing a Master's Certificate, whether of competency or service, is eligible to command any vessels of whatsoever tonnage, and either certificate is sufficient for clearance at the Custom House. But a condition in the Charter-party of vessels taken up by Government, for the conveyance of troops, stores, or emigrants, and also the Regulations of the Principal Steam Packet Companies, require that the Master and principal officers shall possess certificates of competency.

The First Mate may engage as Mate of any kind.

The Only Mate as First Mate when there is no other; or as Second Mate, when there is a First Mate.

The Second Mate is not appropriate for any superior station, and must be employed only in cases where a First Mate is also engaged.

Certificates of Competency or Service may be either of a grade appropriate to the Stations held for the time being, or of any superior grade.

N.B.—Certificates of Character from Owners and Captains, must particularly include the word "sobriety."

Notice to Masters and Only-Mates of Foreign-going Ships.

Board of Trade, *Dec.* 29, 1856.

The following additions to the qualifications now required from persons applying for Certificates of Competency, for Foreign-going Ships, will be made after the 31st of March, 1857:—

All Masters of Foreign-going Ships, in addition to the subjects of examination prescribed in the Notice of Examination, issued in 1855, will be examined in so much of the Laws of the Tides as is necessary to enable them to shape a course, and to compare their soundings with the depths marked on the Charts.

All Only-Mates must be nineteen years of age, and must have been five years at sea; and, in addition to the qualifications required in the notice above referred to, must be able to find the longitude by chronometer, in the usual way.

Examinations of Masters and Mates.

Office of Committee of Privy Council for Trade,
Marine Department, Whitehall, June 10, 1857.

Sir,—I am directed by the Lords of the Committee of Privy Council for Trade, to request that you will call the attention of the Local Marine Board to the following observations, having reference to the subject of the Examinations of candidates for Certificates of Competency.

By the regulations issued by this Board in 1851, Masters and Mates were informed that the standard of Examinations had been made as low as possible, but would be raised from time to time.

In the six years which have since elapsed, the only additions which have been made, are the following, viz.:—Masters are now examined as to the Law of Tides. Only Mates are

required to be nineteen years of age instead of eighteen, and to find the longitude by chronometer; and Second Mates are required to have a knowledge of logarithms, and to be able to complete the day's work.

My Lords do not, at present, contemplate raising the existing standard, but they are desirous that one uniform system should prevail at every port in the United Kingdom, at which examinations are held; and with the view of framing rules to effect this, their lordships have written for information as to the modes in which the examinations are conducted, by the different Examiners.

Notwithstanding the desire expressed in the Circular from this department, of the 15th October, 1855, that the examinations should be as much as possible assimilated at all the ports, my Lords have ascertained, that the systems at present in practice at the different ports, are by no means uniform; and that greater facilities for procuring Certificates of Competency are afforded at some ports than at others. This is obviously objectionable in principle, as well as unfair to the candidates.

It appears, that at some ports a candidate who has passed for any one grade, when presenting himself for a certificate of a higher grade, is examined only for the additional qualifications required for such higher grade, without again passing through the examination for the inferior grade; so that a man having once passed in the use of logarithms, and other subjects belonging to the inferior grade, is not again required, when being examined for a higher class of certificate, to show that he has kept up the knowledge he had previously attained. It is, besides, to be observed, that at some ports, a Master has four days instead of one for the completion of his examination. At other ports, a more strict and less objectionable practice has prevailed.

Bearing this difference in mind, my Lords can have little

doubt to what cause the following important facts are to be attributed.

First.—The numbers of Masters and Mates who have obtained certificates have, at certain ports, increased considerably, whilst at others (including some of the most important) the increase has been comparatively trifling; although the increase in the aggregate number of candidates examined has been from 3,029 in the year 1851, to 5,771 in 1856.

At those ports where candidates for the higher classes of certificates are required to pass in the whole of the subjects of examination, including those for inferior grades, the numbers of examinations have not increased in the same proportion, in which, looking to the size and importance of the port, it was to be expected they would increase, it being doubtless known to the candidates, at which of the ports the examinations are less strict.

Secondly,—In many instances candidates have passed through the various grades with extreme rapidity; cases have been observed, in which persons who have passed as Second Mates only, have, in a few weeks, undergone examinations for the superior grades, and have obtained Master's certificates.

Under these circumstances, my Lords think it their duty to request, that all Local Marine Boards will be so good as to give their Examiners instructions, to require every candidate, for whatever grade he may wish to be examined, to begin his work with No. 1 of the Examination Papers, and work out the whole of the Papers up to that specially appropriate to the grade for which he desires to obtain a certificate, in one day.

I have the honour to be, Sir,

Your obedient servant,

T. H. Farrer.

The Secretary Local Marine Board.

MISCELLANEOUS QUESTIONS IN ARITHMETIC.

[Similar to those given when the Examination was first made compulsory and are introduced here for practice.]

1. Express in figures, ten millions ten thousand and ten.
2. Add together 17984, 739, 9, 6754, 896, 97, and 7493.
3. In 97864 cables, each containing 120 fathoms, how many inches?
4. Divide 874687718592 by 9648.

5. Express in figures, nine hundred and nine thousand and forty.
6. Add together 8,746, 84, 97631, 471, 140011 and 639.
7. In 8694 tons, how many ounces?
8. Divide 5240037752890 by 86321.

9. Express in figures, one hundred and four millions ninety thousand and nine.
10. Add together 768, 4597, 8, 460, 62, 179634 and 98.
11. In 68049 statute miles, how many barleycorns?
12. Divide 6903523318679 by 84097.

13. Express in figures, ninety millions two hundred and four thousand and fifty.
14. Add together 874, 97643, 96, 4, 371, 930872 and 15.
15. In 8076 centuries, how many seconds? $365\frac{1}{4}$ days being reckoned to the year.
16. Divide 7941037222000 by 9839.

17. Express in figures, one hundred millions sixty thousand four hundred and nine.
18. Add together 876, 4973, 64, 9, 754319 and 474.
19. In 769846 statute miles, how many inches?
20. Divide 5517516862240200 by 8609000.

21. Express in figures, nine hundred millions two thousand and one.
22. Add together 8764, 987641, 470, 91, 9, and 8746.

23. In 6785 Great Circles, how many seconds (″) ?

24. Divide 120140420490 by 60070.

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25. Multiply £ 36. 17*s.* 4¾*d.* by 79.

26. If ⅛ of a ship be worth £ 207. 10*s.* 3*d.* what part can be purchased for £ 1245. 1*s.* 6*d.*

27. Required the value of a nugget of gold weighing 84 lbs. at £ 3. 12*s.* 1½*d.* per oz.

EXERCISES IN LOGARITHMS, &c.

Sufficient directions are given to all tables of logarithms* in respect to the method of using them, but the following remarks are for the purpose of enforcing the necessity of having a due regard to the *characteristic* or *index* of a logarithm, the neglect of which is productive of great error.

Take any numbers as 27, 564, 3047; the first consists of two, the second of three, and the third of four *digits* or *integers*. Take also any number 765·476; the figures (765) on the left of the decimal point compose the *integral part*, those on the right (476) are *decimals*. Again take any logarithm as 3·124830, the first figure (3) is called the *index*, and the remaining portion is the *decimal part or mantissa;* now the *mantissa* of the logarithm of any number above 100 is all that is registered in the tables, and the index therefore has to be supplied. These observations being understood, the following rule must be borne in mind.

Rule. The *index* of the logarithm of a number *greater* than unity, is *one less than the number of digits in the integral part*, and when the number is *less* than unity, consisting of decimals only, then add 1 to the number of cyphers before the first significant figure after the decimal point, and subtract

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* See page 280 and five following pages, of the New Edition of Mrs. Janet Taylor's Epitome of Navigation.

this sum from 10, the remainder is the index; the *index* of the logarithm of a decimal fraction, is properly *negative*, but the *arithmetical complement* of it is sometimes used. *Examples.*

No. 3129	Log. 3·495406
312·9	2·495406
31·29	1·495406
3·129	0·495406
·3129	$\bar{1}$·495406 or 9·495406
·03129	$\bar{2}$·495406 or 8·495406
·003129	$\bar{3}$·495406 or 7·495406

It will be perceived from above, that the mantissa remains unaltered, so long as the numbers consist of the *same significant figures*; change the numbers and the mantissa must also change. *Examples.*

No. 2516	Log. 3·400711
303·3	2·481872
6·561	0·816970
·8407	$\bar{1}$·924641 or 9·924641

The reverse of the foregoing rule holds good in every particular, *i.e.* having sought in the tables of logarithms for the number corresponding to the given mantissa, the *index* will determine the *number of digits in the integral parts.*

Examples,

Log. 3·892873	No. 7814
2·954435	900·4
0·620968	4·178
$\bar{1}$·817631 or 9·817631	·6571
$\bar{3}$·176091 or 7·176091	·0015

Examples for Practice.

1. Required the logarithms of the following numbers—

6754	7200	43710	39906	400000
·1463	·00647	3·874	18·006	·0046

2. Find the numbers corresponding to the following logarithms,—

0·768432	0·821567	2·374900	1·610432	4·000710
1·874216	1·914000	3·100300	3·214797	5·001476

3. Find the log. sine of

47° 30′ 52″	170° 30′ 39″	1° 49′ 47″
72 4 25	110 11 18	1 0 40

Find the log. co-sine of

36 7 21	88 40 56	88 59 19
20 8 40	30 0 50	108 40 6

Find the log. tangent of

22 20 11	1 8 7	52 10 46
37 9 41	1 2 18	114 9 30

4. Find the log. co-tangent of

38 50 19	58 43 37	71 43 6
64 10 40	9 8 39	3 7

Find the log. secant of

20 30 15	45 10 19	71 43 6
29 11 40	101 8 7	38 7 4

Find the log. co-secant of

45 8 29	70 30 24	141 16 51
127 30 40	60 11 9	16 0 20

5. Find the arc of the log. sine of

9·180641	9·990640	8·462167	8·846217

co-sine of

9·344178	9·983862	9·876419	8·967391

tangent of

9·642876	10·846215	9·846175	10·060431

co-tangent of

9·742691	10·876432	9·374611	8·460000

secant of

10·034687	10·090188	11·546718	11·200000

co-secant of

10·109761	10·061462	11·467931	11·000873

6. Multiply 4 by 75 by logs.
7. Multiply 75 by 60 by logs.
8. Multiply 701 by 9 by logs.
9. Multiply 1074 by 2 by logs.

10. Multiply 7000 by 1 by logs.
11. Multiply 476 by 682 by logs.
12. Multiply ·3746 by ·6168 by logs and decimals.
13. Find the product of 38, 1·74, 96, and ·0756 by logs.
14. Find the product of 376, 0069, and 1·476 by logs.
15. Find the product of 2·4, ·008, ·62, and 3·1.
16. Divide 66 by 3 by logs.
17. Divide 777 by 11 by logs.
18. Divide 1728 by 144 by logs.
19. Divide 1000 by 1000 by logs.
20. Divide 1010 by 101 by logs.
21. Divide 87469 by 364 by logs.
22. Divide 37 by ·02 by logs and decimals.
23. Divide 76 by 874 by logs.
24. Divide 10 by 5·86 by logs and decimals.
25. Divide 6748 by ·00763 by logs.
26. Divide ·34761 by 2·674 by logs and decimals.
27. Required the square of 46, of 94, of ·163, and of ·0075 by logs.
28. Required the cube of 47, of 63, of ·109, and of ·00861 by logs.
29. Required the square root of 4796, of 746937, and of ·6470 by logs.
30. Required the cube root of 36472, of 62154, and of ·7564 by logs.
31. What is the cost of 243 yards at 9*s.* $3\frac{3}{4}$*d.* per yard, by logs and decimals ?
32. What is the cost of 3 tons, 2 cwt. 3 qrs. at 4*s.* 6*d.* for 7 lbs. by logs ?
33. If 1000 yards cost £70. 15*s.* what does 1 foot cost at the same rate ?
34. If $\frac{7}{8}$ of a lb. cost 4*s.* $8\frac{1}{2}$*d.* what will $27\frac{9}{10}$ lb. cost?

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks.
1						P.M. I take my departure from a point of land in Lat. 34° 51′S. Long. 20° 2′ E. bearing by compass N.N.W $\frac{1}{2}$W distant 17 miles.
2	7	2	S.	N by W.	0	
3	6	4				
4	7	0				
5	7	4				
6	7	0	S. by E.		0	
7	6	8				
8	7	2				
9	6	8	S.E.	N.E.b.E.	$\frac{1}{4}$	
10	6	8				
11	7	4				
12	7	0	East	N.N.E.	$\frac{1}{2}$	
1	6	8				A.M.
2	7	2				
3	6	4				
4	5	6				A current set W.b.S. by compass, at the rate of $2\frac{1}{2}$ miles an hour.
5	6	0	E.N.E.$\frac{1}{2}$E.	North.	$\frac{1}{4}$	
6	6	6				
7	6	4				
8	7	0	N N.W.	N.E.	$\frac{3}{4}$	
9	6	0				
10	6	6				
11	5	4				
12	6	0				Variation $2\frac{1}{4}$ pts. W.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks
1						P.M. I take my departure from a point of land, in Lat. 40° 29′N. Long 124° 32′W. bearing by compass E.$\frac{1}{2}$S. distant 17 miles.
2	4	6	S.W.	N.W.b.N.	0	
3	5	4				
4	6	0				
5	7	0	S.S.W.		0	
6	6	6				
7	6	4				
8	6	6	W.S.W.		$\frac{1}{4}$	
9	7	4				
10	8	0				
11	7	6	N.W.	N.N.E.	$\frac{1}{2}$	
12	7	4				
1	8	0				A.M.
2	7	6				
3	7	4				A current set E.N.E. by compass 14 miles, during the last 10 hours.
4	7	4	W.N.W.		0	
5	6	6				
6	6	4	S.E.b.E.	N.E.b.E.	$\frac{1}{2}$	
7	6	4				
8	5	4				
9	5	4				
10	6	4				
11	7	0			1	Variation $1\frac{1}{4}$ pts. E.
12	8	0				

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way	Remarks.
1						P. M.
2	4	4	W. by S.	S. by W.	0	I take my departure from a point
3	5	6				of land in Lat. 25° 39′S
4	5	6	S. E. by S.	S. W. by S.	¼	Long. 45° 2′E. bearing by
5	6	6				compass N. W. by N. ¼ N.
6	7	6				distant 21 miles.
7	8	2				
8	7	6	S. S. E.	S. W.	1	
9	7	4				
10	6	4				
11	6	6				
12	7	0				A.M.
1	7	0	S. W. by W.	S. E.	½	
2	7	0				
3	7	0				A current set the ship S.W. by S.
4	7	4				by compass, at the rate of
5	6	6				4 miles an hour, during
6	6	0	S.S.W.½W.	E. by N.	0	the last 8 hours.
7	6	0				
8	5	5				
9	6	5				
10	6	0	N. W. ½W.		0	
11	6	5				
12	7	5				Variation 2 pts. W.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks.
1						P. M. I take my departure from a
2	3	4	S. S. E.	S. W.	1	point of land, bearing by
3	3	6				compass S. W. distant 18
4	4	0				miles, in Lat. 37° 35′S.
5	6	2	W. N. W.		1½	Long. 150° 5′E.
6	4	4				
7	5	4				
8	6	4				
9	4	6				
10	2	4	W. by N.	S. W. b. S.	2	
11	5	0				
12	4	4				
1	4	6				A. M.
2	5	6				
3	5	4	S. b. E. ¾ E.	S. W.	1¼	
4	3	2				A current set the ship 18 miles
5	6	4				S. by W. by compass
6	7	7				
7	2	3				
8	4	5	S. S. E.	S. W. b. W.	1¾	
9	2	6				
10	6	2				
11	4	3				
12	5	4				Variation ¾ pts. E.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks.
1						P.M.
2	6	0	S.W.	N. by W.	0	I take my departure from a point
3	5	4				of land, in Lat. 4° 24′N.
4	6	4		N. W. b.N.		Long. 7° 46′W. bearing
5	7	2				N. $\frac{1}{4}$ E. (by compass) dis-
6	7	0	W. by S.		$\frac{1}{2}$	tance 18 miles.
7	6	6				
8	6	4				
9	7	0				
10	8	0				
11	7	6	N. W. byW.	S.W.b.W.	1	
12	7	4				A. M.
1	6	6				
2	6	4				
3	6	2				
4	5	6				A current set the ship E.b.S. $\frac{1}{2}$ S.
5	5	2				(by compass) 15 miles in
6	4	0	S. by E.		$\frac{1}{2}$	the 24 hours.
7	4	6				
8	4	4				
9	5	0				
10	6	0	West.	S. S. W.	$\frac{1}{4}$	
11	6	4				
12	6	6				Variation $1\frac{3}{4}$ pts. W.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks.
1						P.M. I take my departure from a
2						point of land, in Lat. 34°
3						26′S. Long. 172° 38′E.
4						bearing by compass E. by
5	4	2	S. S. W.	N. W.	$\frac{1}{4}$	S. $\frac{1}{2}$S. distant 17 miles.
6	3	4				
7	4	0				
8	6	4				
9	2	6	N. W. b. W.	S. E.	0	
10	6	4				
11	6	0				
12	5	8	S.b W. $\frac{3}{4}$W.	S. E. $\frac{1}{4}$ E.	$2\frac{1}{4}$	
1	6	0				A. M.
2	6	4				
3	4	8				
4	2	4	N. N. E.	N. W.	2	
5	5	5				A current set the ship the last 4
6	6	6				hours $2\frac{1}{2}$ miles an hour,
7	6	5				N. W. $\frac{1}{2}$W. by compass
8	4	3	N.E.	W.	$\frac{1}{4}$	
9	7	4				
10	6	2				
11	4	4				
12	5	7				Variation $1\frac{1}{2}$ pts. E.

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks.
1	7		S.W.	S. S. E.		Left the Cape in Lat. 25′N. Long. 33′W. bearing E.S.E. 18′ by compass. A current at the rate of 3½′ P.H. throughout, E.½N.by compass, Var. 4½ pts. W.
2	6					
3	6	5				
4	6	5				
5	5		S. S. W.	W.	½	
6	5					
7	5					
8	4					
9	4	6	N. E.	E. S. E.	1	
10	4					
11	3	4				
12	3					
1	2	5	N.b.W.½W.	N. E.	2	
2	2	5				
3	2					
4	2					
5	1		Up N.N.W.			Hove to under a close-reefed m. topsail
6	1				5	
7	1					
8	1		Off N. W.			
9	2		S. W.	S. S. E.	2	
10	3					Deviation as per Hand Book, p. 46.
11	4					
12	5					

H.	K.	$\frac{1}{10}$	Courses.	Winds.	Lee way.	Remarks.
1	4		N. N. E.	E.	½	Lat. left 54° 8′N. Long. 179° 6′E. Var. 2 pts. W.
2	4					
3	4	5				
4	4	5				Bearing S.S.E. 21° } Cou.
5	3		N. E.	N. N. W.	½	Set of 2¾ P. H. S. S. E. ½ } Cou.
6	3					
7	4	6				
8	5	4				Deviation see Hand Book, p. 46.
9	5		E.	S. S. E.	1	
10	6					
11	7					
12	7					
1	7		E. S. E.	S.	1	
2	8					
3	8	5				
4	8	5				
5	8		W. N. W.	E. S. E.		
6	9					
7	9					
8	10					
9	11		W. by S.			
10	11					
11	11					
12	12					

ON TIME.

Time being a measured portion of infinite duration, any event which recurs at equal intervals, might be taken as the unit of admeasurement, and to this end, nothing seems more appropriate than that the required standard should be sought among the innumerable celestial bodies, which appear to be continually revolving around our Earth.

Numberless observations, made in different ages of the world, have proved that the time intervening between two consecutive passages of the same star over a given meridian, is uniform and unchanging, Here then, we have a standard more exact than any that could be devised by art. Owing, however, to the elipticity of the earth's orbit, and the plane of the equator not being coincident with that of the ecliptic, this measure of time, (called by astronomers the sidereal day,) which is wholly uninfluenced by these phenomena, does not agree with the interval measured by the apparent revolution of the Sun round our Earth; and since, if the sidereal day, had been adopted as the unit of admeasurement, the day (by which term is understood a certain fixed and uniform period of time,) would have commenced at no regular instant, as regards the rising, setting, or meridian transit of *that* luminary, which is at once the centre of our system, and the source of light and heat; it seems, therefore, not only more natural, but certainly more convenient for the ordinary purposes of life, that the "working day" should be regulated by the Sun.

Now the *true solar*, or apparent day, which is measured by two successive passages of the sun over the meridian of any place on the earth's surface, is a variable quantity; but there is a regular succession of its variations, which, in a certain period, termed a year, come to an end,—to be commenced anew. In order therefore, to obtain a convenient and equable mea-

sure of time, Astronomers assume a *mean solar day*, the length of which is equal to the average of all the apparent solar days in the year.

The interval by which the *apparent* is in excess or falls short of the *mean* day, constitutes the *equation of time;* this difference is greatest about the 3rd of November, and four times in a year, viz. April 15, June 15, September 15, and December 24, it vanishes, or is exceedingly small.

We next notice two methods of *commencing* the day, which, unless fully understood, must be productive of very considerable error in working the various questions which arise in Nautical Astronomy.

1. The *astronomical day* begins at *noon*, and its minor divisions are reckoned from that instant, or $0^h\ 0^m\ 0^s$ to 24^h continuously.

2. The *civil day*, which is the one used in reference to the ordinary transactions of life, commences at *midnight*, and *precedes* the astronomical day by 12 hours, but its minor divisions are *not* counted *successively* to 24 hours; the interval from midnight to noon being styled A.M. and that from noon to midnight again P.M.—each reckoned to 12 hours.

The distinction between the astronomical and civil day being clearly understood, it will at once be evident that from noon to midnight, the day of the month and the hour of the day are the same in both methods of reckoning; but from midnight to noon they differ; in illustration, any phenomena in the Nautical Almanac, indicated as occurring May 3rd, at $8^h\ 25^m$ the *astronomical date*, will coincide with May 3rd, at $8^h\ 25^m$ P.M. *civil time*. Again, any phenomena dated $6^d\ 16^h\ 25^m$, the time here again being *astronomical*, will, when expressed in the *civil* date, be $7^d\ 4^h\ 25^m$ A.M.

The *civil* reckoning is always in advance 12^h of the *astronomical* reckoning, therefore the *civil* time corresponding to any given *astronomical* time, is readily found by *adding* 12^h to the latter, thus, if to March $1^d\ 5^h\ 59^m$ *astronomical* time, be added 12^h, the sum will be March $1^d\ 17^h\ 59^m$, or March $1^d\ 5^h\ 59^m$ P.M. civil time, the *day* remaining the same. Again, to March 1st, $13^h\ 45^m$ *astronomical* time, add 12^h, the sum will be March $2^d\ 1^h\ 45^m$ A.M. civil time, here the date will have changed; of course, to convert *civil* into *astronomical time*, the 12^h must be subtracted from the former.

These differences in expressing the time being clearly understood, it will be seen that a morning observation of a celestial object made under any meridian, say March 20th, (civil time) at $8^h\ 40^m$ A.M. would be represented astronomically thus, March $19^d\ 20^h\ 40^m$; while another observation made on the same day, but in the evening, as thus, March 20th (civil time) at $4^h\ 20^m$ P.M. is expressed in astronomical time, March $20^d\ 4^h\ 20^m$; and the application of the longitude in time, (by addition if westerly, by subtraction if easterly,) to the given or estimated time of observation, will be the corresponding Greenwich date.

By way of illustration, let us suppose an observation to be taken at sea, on January 15th, at $8^h\ 30^m$ A.M. (civil time) in longitude 124°W.; the Greenwich date is obtained as follows:—

Jan. 15th at $8^h\ 30^m$ A.M. is Jan.	14^d	20^h	30^m	astronomical time.
124°W.	+	8	16	
Greenwich date .... Jan.	15	4	46	

Again, suppose another observation taken March 4th, at $9^h\ 4^m$ A.M. in long. 85°E. the Greenwich date is obtained thus:—

March 4th at $9^h\ 4^m$ A.M. = March	3^d	21^h	4^m	astronomical time.
85°E. long................	—	5	40	
Greenwich date............... March	3	15	24	

In the case of an observation made January 15th at $4^h\ 5^m$ P.M. at ship in long. 120°W. the operation is as follows :—

Jan. 15th at $4^h\ 5^m$ P.M. = Jan. 15^d	4^h	5^m	astronomical time.
120°W. long. — +	8	0	
Greenwich date......... Jan. 15	12	5	

And lastly, were the observation taken June 9th at $2^h\ 50^m$ P.M. in long. 104°E. we proceed as follows :—

June 9th at $2^h\ 50^m$ P.M. = June 9^d	2^h	50^m	astronomical time.
104°E. long... = —	6	56	
Greenwich date .... June 8	19	54	

These examples taken in connexion with the three paragraphs immediately preceding them, will, we trust, make the relation between the *civil* and *astronomical day* clear, and thus be a guide to the method of determining the correct Greenwich date, and as all the elements of the heavenly bodies given in the Nautical Almanac, bear reference to the *astronomical day*, its relation to the civil mode of reckoning must never be lost sight of; for, unless the true *Greenwich Astronomical date* be known at the time the observation is made, to determine latitude, longitude, or the variation of the compass, &c. it is impossible that the solution of the question can be correct.

The sidereal day, to which we have already referred, consists of $23^h\ 56^m\ 4{\cdot}09^s$ mean solar time. In the determination of certain elements by means of a Planet, the Moon, or a Fixed Star, the operation is somewhat shortened by a knowledge of this method of reckoning.

We have made these remarks with a view to impress on Navigators, the importance of making themselves perfectly acquainted with *time,* which can be done by a careful perusal of the article on that subject in their "Epitome," and it cannot be too strongly urged, that it is also especially desirable, that every one using the Nautical Almanac, should make himself thoroughly acquainted with its contents, to accomplish which, it is necessary to peruse *very attentively* the "Explanations," at the end of that book.

TIDES.

To find what water there may be on any bar or harbour, at any time of tide.

Rule.—To the difference between the height of high water at the given place, and the half mean spring range, add or subtract from it the number found in Table B in the Admiralty Tide Table, page 98, according to the direction there given, the result will give the height of the tide above zero, or low-water mark at the time required.

Example.—Required the height of the tide above zero, at Liverpool, on March 19, A.M. at 4^h after high water.

Height of high water (by the tables).......................	27ft.	8in.
Half mean spring range	13	0
Height above the half-tide or mean level of the sea	14	8
Half mean spring range	13	0
By table (B) 14ft. 8in. gives................................	7	4
Height of the tide above zero at 4h. after high water ...	5	8

Paper I.

For Second Mate.

1. Multiply 76 by 43 by logarithms.
2. Divide 144 by 4 by logarithms.
3. In latitude 33°, the departure made was 130m: required the difference of longitude by parallel sailing.
4. January 29, 1861: long. 80° 30'E.: observed meridian altitude ☉̲ 59° 10': sun N. of observer: index error 1' 2" to add: eye 18 feet: required the latitude.

Additional for Only Mate.

5. Compute the course and distance by Mercator's sailing from Cape Voltas, lat. 28° 44'S. long. 16° 32'E.: to Charleston, lat. 32° 41'N. long. 79° 53'W.
6. Jan. 6, 1861: at $6^h\ 25^m\ 32^s$ A.M. apparent time at ship: lat. 38° 5'S.: long. 134° 22'W.: the sun's rising amplitude was observed to be E.byS.¾S.: required the variation of the compass.
7. Jan. 6, 1861: required the A.M. and P.M. tides at N. Shields.*

Additional for Chief Mate.

8. Jan. 6, 1861: at $3^h\ 47^m\ 18^s$ P.M. mean time at ship: lat. 37° 14'S.: long. 142° 3'W.: observed altitude ☉̲ 39° 8' 30": index error 32" to add: eye 19 feet: sun's bearing by azimuth compass W. by S.: required the variation of the compass.
9. Jan. 30, 1861: P.M. at ship: lat. 39° 11'S.: observed altitude ☉̲ 27° 20': index error 1' 10" to subtract: eye 20 feet: time by chronometer $30^d\ 2^h\ 5^m\ 39^s$, which had been found $14^m\ 15^s$ fast on mean time at Greenwich, Oct. 17, 1859, and losing $1{\cdot}2^s$ daily: required the longitude.
10. Jan. 6, 1861: A.M. at ship lat. by account 8° 56'N.: long. 88° 57'E.: observed altitude ☉̲ near the meridian 58° 4' 20": observer N. of sun: index error 1' 17" to add: eye 20 feet: time by watch $6^d\ 0^h\ 2^m\ 30^s$, which had been found $21^m\ 6^s$ fast on apparent time at ship, but ship had made 16' diff. long. to E. since the error for time had been determined: required the latitude.

Additional for Master Ordinary.

11. Correct the following courses for the local attraction, as given at page 46, N.E.—E. by S.—S.S.W.—N. by W.—E.N.E.
12. Jan. 14, 1861: long. 20°W.: the observed meridian altitude of Sirius, (*a* Canis majoris,) being 37° 50' 20": observer N. of the star: index error 1' 4" to add: eye 19 feet: required the latitude.

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* See page 35, for further information respecting the Tides.

Paper II.

For Second Mate.

1. Multiply 109 by 47 by logarithms.

2. Divide 786 by 393 by logarithms.

3. In latitude 44°, the departure made was 95m.: required the difference of longitude by parallel sailing.

4. Feb. 25, 1861: long. 36° 15′W.: observed meridian altitude ☉ 42° 59′: observer N. of sun: index error 1′ 22″ to subtract: eye 20 feet: required the latitude.

Additional for Only Mate.

5. Compute by Mercator's sailing, the course and distance from Point de Galle, lat. 6° 1′N.: long. 80° 14′E.: to Zanzibar S. Point, lat. 6° 10′S.: long. 39° 15′E.

6. Feb. 14, 1861, at 6^h 19^m 40^s P.M. apparent time at ship: lat. 20° 5′S.: long. 106° 5′E.: the sun's setting amplitude was observed to be W.byS.: required the variation of the compass.

7. Feb. 15, 1861: required the A.M. and P.M. tides at Caldy Island.

Additional for Chief Mate.

8. Feb. 16, 1861: at 8^h 14^m 34^s A.M. mean time at ship: lat. 16° 7′N: long.144° 49′E: observed altitude ☉ 30° 18′ index error 1′ 39″ to subtract: eye 17 feet: sun's bearing from the mean of magnetic azimuths S.69° 15′E.: required the variation of the compass.

9. Feb. 15, 1861: A.M. at ship: lat. 26° 14′N.: observed altitude ☉ 28° 0′ 30″: index error 1′ 13″ to add: eye 19 feet: time by chronometer 14^d 23^h 4^m 46^s which was 5^m 2^s fast on mean time at Greenwich, Sept. 13, 1859, and gaining $0^s{\cdot}8$ daily: required the longitude.

10. Feb. 24, 1861: P.M. at ship: lat. by account 57° 56′S.: long. 0° 3′W.: observed altitude ☉ near the meridian 41° 0′ 30″: zenith S. of the sun: index error 1′ 46″ to subtract: eye 16 feet: time by watch 23^d 23^h 59^m 40^s which was found 26^m 30^s slow on apparent time at ship, but ship had made 18′ diff. long. to W., since the error for time had been determined: required the latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 46, East—E.S.E.—N.N.W.—W.S.W.—S.

12. July 1, 1861: long. 87°E.: the observed meridian altitude of Antares, (α Scorpii) being 68° 45′ 30″: star N. of observer: eye 21 feet: required the latitude.

Paper III.

For Second Mate.

1. Multiply 706 by 9 by logarithms.

2. Divide 1728 by 144 by logarithms.

3. In latitude 54°, the departure made was 60m.: required the difference of longitude by parallel sailing.

4. March 21, 1861: long. 145° 30'E.: observed meridian altitude ☉ 67° 5′ 30″: observer N. of sun: eye 19 feet: index error 39″ to add: required the latitude.

Additional for Only Mate.

5. Compute by Mercator's sailing, the course and distance from Halifax, lat. 44° 39'N.: long. 63° 37'W.: to Cape Town, lat. 33° 56'S.: long. 18° 28'E.

6. March 5, 1861: at $6^h\ 21^m\ 40^s$ A.M. apparent time at ship: lat. 41° 2'N.: long. 133° 5'W.: the sun's rising amplitude was observed to be E.$\frac{3}{4}$N.: required the variation.

7. Required the A.M. and P.M. tides at the Nore Light, on March 6, 1861.

Additional for Chief Mate.

8. March 14, 1861: at $4^h\ 11^m\ 6^s$ P.M. mean time at ship: lat. 4° 22'S.: long. 74° 4'E.: the observed altitude ☉ 29° 29′ 10″, bearing by azimuth compass N. 83° 45'W.: index error + 2′ 40″: eye 20 feet: required the variation.

9. March 24, 1861, P.M. at ship: lat. 9° 4'S.: observed altitude ☉ 29° 50′ 30″: index error + 1′ 2″: eye 17 feet: time by chronometer $24^d\ 1^h\ 31^m\ 3^s$, which had been found $1^m\ 53^s$ fast on mean time at Greenwich Jan. 2, and losing $0^s{\cdot}8$ daily: required the longitude.

10. March 22, 1861, A.M. at ship: lat. by account 43° 17'N. long. 15° 16'W.: observed altitude ☉ near the meridian 47° 2′ 10″S. index error—1′ 31″: eye 16 feet: time by watch $22^d\ 0^h\ 38^m\ 10^s$, which had been found $58^m\ 54^s$ fast on apparent time at ship, but the ship had made 15′ diff. long. to W. since the error for time had been determined: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 46, E. $\frac{1}{2}$ N.—E. by S. $\frac{1}{2}$ S.—N. by W.—S. W. by W.

12. March 1, 1861: long 37°W.: the observed meridian altitude of Aldebaran, (α Tauri) being 48° 45′ 30″: star S. of observer: eye 21 feet: required the latitude.

Paper IV.

For Second Mate.

1. Multiply 3009 by 4 by logarithms.

2. Divide 9460 by 86 by logarithms.

3. In latitude 50°, the departure made was 63m.: required the difference of longitude by parallel sailing.

4. April 7, 1861 : long. 39° 45′W. : observed meridian altitude ☉ 38° 0′ 15″ observer N. of sun : eye 17 feet : required the latitude.

Additional for Only Mate.

5. Compute by Mercator's sailing, the course and distance from Angra Pequena, lat. 26° 38′S. : long. 15° 8′E. : to Cape St. Roque, lat. 5° 28′S. : long. 35° 17′W.

6. April 13, 1861 : at 6^h 13^m P.M. apparent time at ship : lat. 20° 16′N. : long. 118° 2′E. : the sun's setting amplitude was observed to be W.¾N. : required the variation.

7. April 5, 1861 : required the A.M. and P.M. tides at Torbay.

Additional for Chief Mate.

8. April 15, 1861 : at 7^h 21^m A.M. mean time at ship : lat. 24° 44′N. : long. 91° 4′W. : observed altitude ☉ 22° 8′ 30″ bearing by azimuth compass N.80° 30′E. : eye 20 feet : index error + 2′ 8″ required the variation.

9. April 16, 1861 : P.M. at ship ; lat. 43° 11′S : observed altitude ☉ 19° 50′ 20″ : index error — 1′ 17″ : eye 21 feet : time by chronometer 15^d 22^h 48^m 18^s which had been found 5^m 58^s fast on mean time at Greenwich Jan. 20, and losing $1^s{\cdot}4$ daily : required the longitude.

10. April 26, 1861 : A.M. at ship : lat. by account 29° 9′S. long. 0° 17′E. : observed altitude ☉ near the meridian 46° 30′ 40″ : sun N. of observer : eye 17 feet : time by watch 26^d 0^h 0^m 5^s which had been found 30^m 5^s fast on apparent time at ship, but the ship had made 17′ diff. long. to E. since the error for time had been determined : required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 46, S.W.—N.W.—W.N.W.—South.

12. Dec. 3, 1861 : long. 175°E. : the observed meridian altitude of *α* Arietis being 46° 20′ : star N. of observer : eye 20 feet : required the latitude.

Paper V.

For Second Mate.

1. Multiply 200·6 by 7 by logarithms.

2. Divide 16·04 by 4·4 by logarithms.

3. In latitude 57°, the departure made was 91m.: required the difference of longitude by parallel sailing.

4. July 5, 1861: long. 85° 15′E.. observed meridian altitude $\underline{\odot}$ 32° 11′ 40″: zenith S. of the sun: eye 20 feet: required the latitude.

Additional for Only Mate.

5. Required the course and distance by Mercator's sailing, from Port Jackson, lat. 33° 51′S.; long. 151° 18′E.: to Acapulco, lat. 16° 51′N.: long. 99° 52′W.

6. July 18, 1861, at 7^h 54^m A.M. apparent time at ship: lat. 51° 22′S.: long. 93° 55′W.: the sun's rising amplitude was observed to be N.E.½E.: required the variation.

7. Required the A.M. and P.M. tides, July 12, 1861, at Whitby.

Additional for Chief Mate.

8. July 10, 1861: at 8^h 56^m 50^s A.M. mean time at ship: lat. 38° 8′S.: long. 77° 48′W.: observed altitude $\underline{\odot}$ 15° 1′ 30″, bearing by azimuth compass N. 29° 40′E.: eye 21 feet: index error + 1′ 37″: required the variation.

9. July 16, 1861: A.M. at ship: lat. 12° 52′N.: observed altitude $\underline{\odot}$ 28° 48′ 30″: index error, —1′ 14″: eye 20 feet: time by chronometer 16^d 2^h 43^m 42^s, which had been found 2^m 51^s slow on mean time at Greenwich, April 20, and gaining $1{\cdot}3^s$ daily: required the longitude.

10. July 25, 1861: P.M. at ship: lat. by account 43° 42′S.: long. 23° 20′E.: observed altitude $\underline{\odot}$ near the meridian 26° 14′ 20″: sun N. of observer: eye 19 feet: time by watch 24^d 22^h 59^m, which had been found 1^h 27^m 16^s slow on apparent time at ship, but the ship had made 14′ diff. of long. to W. since the error for time had been taken: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 46, West—N.E. by E.—S.W. by W.—E.N.E.

12. July 6th, 1861: long. 88° 45′E.: the observed meridian altitude of Markab (α Pegasi) being 39° 40′ 10″: observer S. of the star: eye 21 feet: required the latitude.

Paper VI.

For Second Mate.

1. Multiply 7·64 by 1·6 by logarithms.

2. Divide 34·76 by 1·2 by logarithms.

3. In latitude 40°, the departure made was 108m.: required the difference of longitude by parallel sailing.

4. Sept. 23, 1861: long. 160° 30′W.: observed meridian altitude $\underline{\odot}$ 48° 0′ 30″: observer N. of the sun: index error 1′ 36″ to subtract; eye 16 feet: required the latitude.

Additional for Only Mate.

5. Required the course and distance by Mercator's sailing, from Cape Hatteras, lat. 35° 14′N.: long. 75° 30′W.: to Cape Frio, lat. 18° 23′S.: long. 12° 2′E.

6. Oct. 1, 1861: at $6^h\ 11^m\ 26^s$ A.M. apparent time at ship: lat. 42° 10′N.: long. 56° 1′W.: the sun's rising amplitude was observed to be E.¾S.: required the variation.

7. Oct. 8, 1861: required the A.M. and P.M. tides at Dunkerque, France.

Additional for Chief Mate.

8. Oct. 1, 1861: at $4^h\ 54^m\ 30^s$ P.M. mean time at ship: lat. 17° 8′S.: long. 45° 34′E.: the observed altitude $\underline{\odot}$ 13° 57′ 30″, bearing by azimuth compass N. 70° 45′W.: index error 1′ 25″, to add: eye 19 feet: required the variation.

9. Oct. 26, 1861: A.M. at ship: lat. 28° 4′N.: observed altitude $\underline{\odot}$ 25° 0′ 30″: index error +20″: eye 17 feet: time by chronometer $26^d\ 7^h\ 46^m\ 48^s$ which had been found $3^m\ 45^s$ fast on mean time at Greenwich, April 4th, and losing $3{\cdot}2^s$ daily: required the longitude.

10. Oct. 29, 1861: A.M. at ship: lat. 44° 58′N.: long. 26° 19′W. observed altitude $\underline{\odot}$ near the meridian 31° 0′ 20″S.: eye 16 feet: time by chronometer $29^d\ 1^h\ 30^m\ 10^s$, which had been found $1^h\ 55^m\ 56^s$ fast on apparent time at ship, but the ship had made 10½′ diff. long. to E. since the error for time had been determined: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 46, W.byS.—S.byW.—E.byS.½S.—N.W.½W.

12. Oct. 4, 1861; long. 36° 15′W.: the observed meridian altitude of Fomalhaut being 69° 30′ 40″: star S. of observer: index error +1′ 11″: eye 18 feet; required the latitude.

Paper VII.

For Second Mate.

1. Multiply ·605 by ·09 by logarithms.

2. Divide ·176 by 1·46 by logarithms.

3. In latitude 38°, the departure made was 166m.: required the difference of longitude by parallel sailing.

4. Sept. 23, 1861: long. 34°W.: the observed meridian altitude $\underline{\odot}$ 57° 20′ 30″: oberver S. of sun: index error 1′ 20″ to add; eye 21 feet: required the latitude.

Additional for Only Mate.

5. Determine by Mercator's sailing, the course and distance from Cape Horn, lat. 55° 59′S.: long. 67° 16′W.: to Cape of Good Hope, lat. 34° 22′S. long. 18° 29′E.

6. Dec. 16, 1861: at 4^h 35^m 32^s A.M. apparent time at ship: lat. 40° 4′S.: long. 4° 8′E.: the sun's rising amplitude was observed to be S.E.¾E.: required the variation.

7. Dec. 21, 1861: required the A.M. and P.M. tides at Peterhead.

Additional for Chief Mate.

8. Dec. 16, 1861: at 8^h 3^m A.M. mean time at ship: lat. 15° 12′N.: long. 77°W.: observed altitude $\underline{\odot}$ 20° 16′ 20″: index error +1′ 6″: eye 17 feet: sun's bearing by azimuth compass S.66° 10′E.: required the variation.

9. Dec. 25, 1861, P.M. at ship: lat. 30° 16′S.: observed altitude $\underline{\odot}$ 50° 10′ 15″: index error —34″: eye 19 feet: time by chronometer 24^d 17^h 20^m 1^s, which had been found 5^m 27^s slow on mean time at Greenwich, July 13, and gaining 6^s daily: required the longitude.

10. Dec. 13, 1861, A.M. at ship: lat. by account 62° 34′S.: long. 12° 11′E.: observed altitude $\underline{\odot}$ near the meridian 50° 3′ 15″N.: index error —54″: eye 16 feet: time by chronometer 12^d 22^h 39^m 4^s, which had been found 49^m 48^s slow on apparent time at ship, but the ship had made 17′ diff. long. to W. since the error for time had been determined: required the true latitude.

Additional for Master Ordinary.

11. Correct the following courses for local attraction, as given at page 46, E.½.S.—N.E. ½ E.—N. by E. ½ E.—N.N.W.

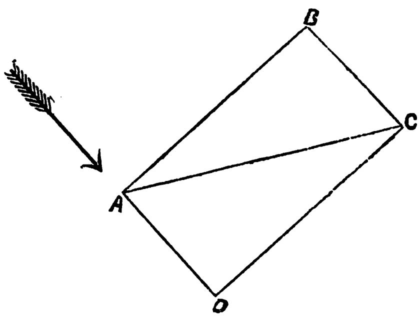
12. Dec. 26, 1861: long. 165°W.: observed meridian altitude of Canopus (α Argus) 67° 30′: star S. of observer: eye 18 feet: required the latitude.

EXERCISE ON CURRENT SAILING.

Suppose that a ship bound from A to B, is influenced by a current, setting as directed by the arrow, what will be her course?

It is first to be understood that the *distance* set, is indicated by the *length* of the arrow; if necessary to obtain the course, draw a compass, and notice the direction of AC as near as you can.

Draw AB and BC of the same length, and parallel to the arrow, then join AC, this will be the course made by the ship, caused by the set of the current.



LOCAL ATTRACTION.

DEVIATION OF THE COMPASS.*

Local Attraction is a term used to denote the influence of iron in disturbing the direction of the magnetic needle,

* For fuller and more complete information on this subject, with rules for the application of Deviation and Variation, see Mrs. Janet Taylor's Epitome, page 59.

whereby, according to the extent and position of that metal in respect to the compass, a greater or less amount of *deviation from the magnetic meridian* is the result. This derangement of the compass, some 30 years ago scarcely noticed, must have been the source of numberless accidents to vessels, often accompanied by a great sacrifice of human life; for since that period, the careful researches of scientific observers have proved, that it would be extremely hazardous to allow the ships of H.M. navy, steamers, or iron-built vessels to proceed to sea, unless the amount of errors arising from the local attraction has been previously determined; it may suffice to mention, in illustration, that in some screw steamers the deviation, with the ship's head South, has amounted to more than fifteen points.

It must not be supposed that the compasses on board vessels built of wood, are wholly free from the effect of local attraction: under ordinary circumstances, with no undue proportion of iron in the ship, the deviation may not be so great as to produce any serious error on the courses made: but the case is materially altered when the cargo consists in part, or wholly, of iron,—or in fact, when any quanity of that metal is placed in the vicinity of the binnacle.

The amount of deviation on a given point of the compass is by no means a constant quantity, but it differs in different vessels, each having a local attraction peculiarly its own; it also varies with change of position on the globe; in north magnetic latitude the north pole is attracted, in south magnetic latitude, the south pole,—increasing or decreasing as the dip of the needle increases or decreases: nor is it by any means the same in all parts of the same ship, and it may even alter from circumstances connected with the vessel itself, or the needle,—or even both. It is therefore necessary that masters should be able to ascertain, as well as know how to

apply, the errors arising from the local magnetic disturbance: for this purpose two methods may be adopted,—the first being the most approved.

Method 1.—*With Two Compasses.*—The ship must be placed in such a position that she may be gradually swung, and the two compasses being compared together to note their agreement, let one of them be placed in the binnacle in its usual position, and the other taken on shore beyond the influence of the attractive force; adopt such means that a good bearing of each may be taken, and as the ship's head is brought to each point in succession of the compass on board, at that instant let observations be made, thus,—the person on shore must take the bearing of the compass in the binnacle, and the person on board must take the bearing of the compass on shore, proceeding in this manner through the 32 points; these bearings must be tabulated after the following method:—

Direction of Ship's Head.	Bearing of Shore Compass, from Compass on Board.	Bearing of Compass on Board, from Shore Compass.	Difference of bearings or Deviation.

The difference between the bearings will be the amount of deviation due to the local attraction of the ship, and is named *East*, when the north point of the needle is drawn to the eastward or right hand,—*West*, when it is drawn to the westward or left hand; and must be applied to the ship's courses in the same manner as the variation of the compass.

Method 2.—*With One Compass.*—Having determined the true bearing of a conveniently distant object, let the ship be carefully swung to each point of the compass, and on each occasion, let the bearing of the object be taken; the difference between the true and observed bearing, will be the error of the compass, to be named and applied as in the former case.

From the annexed Table, correct the courses given in the previous Papers.

Direction of Ship's Head.	Deviation of Compass.	Direction of Ship's Head.	Deviation of Compass.
N.	2° 45′ E.	S.	3° 0′ W.
N. by E.	4 57	S. by W.	4 20
N. N. E.	7 30	S. S. W.	5 0
N. E. by N.	9 0	S. W. by S.	6 7
N. E.	10 0	S. W.	7 0
N. E. by E.	10 55	S. W. by W.	7 27
E. N. E.	10 40	W. S. W.	7 50
E. by N.	9 55	W. by S.	8 20
E.	8 50	W.	8 50
E. by S.	7 15	W. by N.	8 10
E. S. E.	5 35	W. N. W.	6 50
S. E. by E.	3 40	N. W. by W.	5 40
S. E.	1 50	N. W.	4 50
S. E. by S.	0 20 E.	N. W. by N.	3 20
S. S. E.	0 56 W.	N. N. W.	1 40 W.
S. by E.	2 20	N. by W.	1 10 E.

THE ADJUSTMENT OF THE SEXTANT.

1.—*The Index Glass should be perpendicular to the plane of the Instrument.* To determine if it be so, bring the vernier to the middle of the arc, and with the limb turned from the observer, look obliquely into the mirror, then if the reflected and true arcs appear as one continued arc of a circle, the index glass is in perfect adjustment.

2.—*The Horizon Glass should be perpendicular to the plane of the Instrument.* With 0 on the vernier coinciding with 0 on the arc, hold the sextant horizontally, and looking at the horizon, observe if the reflected and true horizons are in one line; or, the instrument being held perpendicularly, look at any convenient object, as the sun, sweep the index glass along the limb, and if the reflected image pass exactly over the direct image without any lateral projection, the horizon glass is perpendicular.

3.—*The Horizon Glass should be parallel with the Index Glass, when* 0 *on the vernier exactly coincides with* 0 *on the arc.* To ascertain this, hold the instrument vertically, and direct the sight, through the telescope or sight vane, to the horizon, and if the reflected and true horizons form one continuous line, the horizon glass is parallel with the index glass.

4.—*To adjust the line of Collimation*, or to set the axis of the telescope parallel to the plane of the sextant. Fix the telescope in its place, taking care that two wires are parallel with the plane of the instrument; select two objects, as the sun and moon, or moon and star, which are more than 90° distant from each other, bring them into contact on the wire nearest to the instrument; then by slightly moving the sextant, see how they appear on the other wire; if they are still in contact the *Line of Collimation is in adjustment*; but if the bodies

separate when brought to the far wire, the object end of the telescope *inclines towards* the plane of the sextant; if they overlay, it *declines from* the plane.

5.—*To determine the Index Error,* measure the sun's diameter on the arc of the instrument, and on the arc of excess, which is done by holding the sextant perpendicularly, and bringing the true and reflected suns in exact contact on each side of 0; *half the difference of the two readings* will be the index error, which is additive when the reading on the arc of excess is the *greater,* but subtractive when the reading on the arc of excess is the *less* of the two.

MERCATOR'S CHART.

Mercator's Chart, which has been compared to a cylinder unrolled, is a convenient and ingenious method of representing the surface of the globe as if it were a plane. The lines drawn from the top (North) to the bottom (South) of the chart are meridians; those from left (West) to right (East) are parallels: the top and bottom are graduated parallels; the extreme right and left are graduated meridians. The latitnde of any place is measured on a graduated meridian, and its longitude on a graduated parallel.

To find the course between two places, which is represented on this chart by a straight line, lay the edge of a parallel rule on the places, then slide it down until it comes exactly on the centre of one of the compasses, and the course can be read off.

To find the distance between two places, one general rule will apply;—Take *half* the distance between them; the point midway between the two places indicates the latitude to which one leg of the compass is to be referred on the graduated meridian; carrying the other leg first North and then South

of that latitude, the degrees and minutes intercepted between the extreme points will be the *approximate* distance when the two places are on the same parallel, or when they lie obliquely, and the *true* distance when they are on the same meridian.

It must be remembered that when the *true* course between two places is known, *Easterly* variation allowed to the *left* and *Westerly* variation to the *right* of this, will give the *compass* course.

To ensure accuracy in determining the place of a ship by cross bearings, the difference of the bearings should be as near as possible 90°.

THE LOG-LINE.

The speed of a vessel is ascertained by means of the Log-line, and a sand glass running a given number of seconds. To determine the length of a knot on the log-line, we have the following rule: The length of the knot (in feet) must bear the same proportion to a geographical mile (in feet), that the seconds of the glass used at the time of heaving the log, bear to the seconds contained in an hour; from which it follows, that the number of knots and parts of a knot run during the interval indicated by the glass, will give the number of miles and parts of a mile the ship has sailed in an hour, supposing the rate of sailing to be uniform.

The geographical mile being about 6080 feet, we have for glasses running 28^s and 30^s respectively, the following pro. portions:

$$3600^s : 28^s :: 6080 \text{ ft.} : 47 \cdot 288 \text{ ft.} = 47 \text{ ft.}\ 3\tfrac{1}{2} \text{ in.}$$
$$3600^s : 30^s :: 6080 \text{ ft.} : 50 \cdot 666 \text{ ft.} = 50 \text{ ft.}\ 8 \text{ in.}$$

the required lengths of the knot, but if 80 feet be rejected from the geographical mile, and the first and third terms of the proportion reduced, by dividing them by 600, the statements become

$$6^s : 28^s :: 10 \text{ ft.} : 46 \cdot 66 \text{ ft.} = 46 \text{ ft. } 8 \text{ in. nearly.}$$
$$6^s : 30^s :: 10 \text{ ft.} : 50 \text{ ft.}$$

hence the method very commonly adopted to ascertain the length of the knot; viz. annex a cipher to the number of seconds run by the glass, and then divide by 6.

The log-line must always have a sufficient quantity of what is termed "stray line," in excess of the admeasured portion, in order to allow the log to get clear of the eddy of the ship's wake; this must be determined by the size of the vessel.

It is recommended to divide the knot to tenths.

THE LEAD LINE.

In nautical phrase, the Lead Line has "nine marks and eleven deeps."—

At 2 fathoms the mark is	Leather,
3	Leather,
5	White Rag,
7	Red Rag,
10	Leather with a round hole in it.
13	Blue Rag,
15	White Rag,
17	Red Rag,
20	A piece of cord with two knots.

The Deep sea Lead Line is marked in a similiar manner to the 20 fathoms, after which a piece of cord with an additional knot to every 10 fathoms is fixed to the line, and between the tens a piece of leather to denote five fathoms.

ADMIRALTY NOTICE respecting LIGHTS and FOG SIGNALS to be carried and used by Sea-going Vessels, to prevent Collision.

By the Commissioners for executing the office of Lord High Admiral of the United Kingdom of Great Britain and Ireland, &c.

By virtue of the power and authority vested in us, we hereby revoke, as from and after the thirtieth day of September, 1858, the regulations made and published by us on the first day of May, 1852, relating to the Lights to be carried by Sea-going Vessels to prevent collision: And we hereby make the following regulations, and require and direct that the same be strictly observed and carried into effect on and after the first day of October, 1858.

STEAM VESSELS.

All Sea-going Steam Vessels, when under Steam, shall, between sunset and sunrise, exhibit the following Lights:

1. A bright White Light at the Foremast Head.
   A Green Light on the Starboard side.
   A Red Light on the Port side.

2. The Mast-head Light shall be so constructed as to be visible on a dark night, with a clear atmosphere, at a distance of at least 5 miles, and shall show an uniform and unbroken light over an arc of the horizon of 20 points of the compass, and it shall be so fixed as to throw the light 10 points on each side of the ship, viz.: from right ahead to 2 points abaft the beam on either side.

3. The Green Light on the Starboard side and the Red Light on the Port side shall be so constructed as to be visible on a dark night, with a clear atmosphere, at a distance of at least 2 miles, and show an uniform and unbroken light over an arc of the horizon of 10 points of the compass, and they shall be so fixed as to throw the light from right ahead to 2 points abaft the beam on the Starboard and on the Port sides respectively.

4. The side Lights are to be fitted with inboard screens projecting at least 3 feet forward from the light, so as to prevent the lights from being seen across the bow.

5. Steam Vessels under Sail only, are not to carry their mast-head Light.

Fog Signals.

All Sea-going Steam Vessels, whether propelled by paddles or screws, when their steam is up, and when under way, shall in all cases of Fog use as a Fog Signal a Steam Whistle, placed before the Funnel at not less than 8 feet from the deck, which shall be sounded once at least every five minutes; but when the steam is not up, they shall use a Fog Horn or Bell, as ordered for Sailing Ships.

SAILING VESSELS.

1. All sea-going Sailing Vessels when under-way or being towed, shall between sunset and sunrise exhibit a Green Light on the Starboard side and a Red Light on the Port side of the vessel, and such Lights shall be so constructed as to be visible on a dark night, with a clear atmosphere, at a distance of at least 2 miles, and shall show an uniform and unbroken light over an arc of the horizon of 10 points of the compass, from

right a-head to 2 points abaft the beam on the Starboard and on the Port sides respectively.

2. The coloured Lights shall be *fixed* whenever it is practicable so to exhibit them; and shall be fitted with inboard screens projecting at least 3 feet forward from the Light, so as to prevent the Lights being seen across the bow.

3. When the Coloured Lights cannot be fixed (as in the case of small vessels in bad weather), they shall be kept on deck between sunset and sunrise, and on their proper sides of the vessel, ready for instant exhibition, and shall be exhibited in such a manner as can be best seen on the approach of, or to, any other vessel or vessels, in sufficient time to avoid collision, and so that the Green Light shall not be seen on the Port side, nor the Red Light on the Starboard side.

Fog Signals.

All Sea-going Sailing Vessels, when under-way, shall, in all cases of Fog, use when on the Starboard Tack a Fog Horn, and when on the Port Tack shall Ring a Bell. These signals shall be sounded once at least every five minutes.

PILOT VESSELS.

Sailing Pilot Vessels are to carry only a White Light at the Mast-head, and are to exhibit a Flare-up Light every 15 minutes, in accordance with Trinity House regulation.

VESSELS AT ANCHOR.

All Sea-going Vessels when at anchor in roadsteads or fairways, shall between sunset and sunrise exhibit where it

can best be seen, but at a height not exceeding 20 feet above the hull, a White Light in a Globular Lantern of 8 inches in diameter, and so constructed as to show a clear, uniform, and unbroken light all round the horizon, at a distance of at least one mile.

Given under our hands this 24th day of February, 1858.

CHARLES WOOD.
R. S. DUNDAS.

By Command of their Lordships,
(Signed) W. G. ROMAINE,
Secretary.

THE RULE OF THE ROAD.

1. Sailing Vessels having the wind fair, give way to those on a wind.
2. Vessels close hauled on the starboard tack, always keep their wind.
3. Vessels close hauled on the port tack, must give way to those on the starboard tack.

N.B.—Steamers are considered as vessels with a fair wind.

In connexion with this *most important* subject, the following remarks by an able correspondent of the "*Mercantile Marine Magazine,*" (May 1855, Vol. II. page 172,) on the construction of the rules as they are set forth in the "Merchant Shipping Act," will be useful, as the writer has endeavoured to explain, for the benefit of seamen, one or two points to which it is quite essential for them to attend.

The rules run thus,—

Section 296. "Whenever any ship, whether a steamer or

sailing-ship, proceeding in one direction, meets another ship, whether a steam or sailing ship, proceeding in another direction, so that if both ships were to continue their respective courses they would pass so near as to involve any risk of a collision, the helms of both ships shall be put to port, so as to pass on the port side of each other; and this Rule shall be obeyed by all steam-ships and by all sailing-ships, whether on the port or starboard tack, and whether close-hauled or not, unless the circumstances of the case are such as to render a departure from them necessary, in order to avoid immediate danger, and subject also to the proviso that due regard shall be had to the dangers of the navigation, and as regards sailing-ships on the starboard tack close-hauled, to the keeping such ships under command."

297. "Every steam-ship, when navigating any narrow channel, whenever it is safe and practicable, shall keep to that side of the Fairway or Mid-channel which lies on the starboard side of such steam-ship."

298. "If in any case of collision it appears to the Court before which the case is tried, that such collision was occasioned by the non-observance of any rule for the exhibition of lights, or the use of fog signals, issued in pursuance of the powers hereinbefore contained, or of the foregoing Rule as to the passing of steam and sailing ships, or of the foregoing Rule as to a steam-ship keeping to that side of a narrow channel which lies on the starboard side, the owner of the ship by which such rule has been infringed, shall not be entitled to recover any recompense whatever for any damage sustained by such ship in such collision, unless it is shown to the satisfaction of the Court that the circumstances of the case made a departure from the Rule necessary."

299. "In case any damage to person or property arises from the non-observance by any ship of any of the said rules, such damage shall be deemed to have been occasioned by wilful default of the person in charge of the deck of such ship at the

time, unless it is shown to the satisfaction of the Court that the circumstances of the case made a departure from the Rule necessary."

By these rules, vessels, when *meeting*, are directed to give the Port-helm in all cases where, if they were to continue their respective courses, they would involve the risk of a collision. It must not be supposed, however, from this apparently-imperative rule, that a blind adherence to the Port-helm *on all occasions*, of vessels approaching each other, is for a moment enjoined by the Act, nor that upon every occasion of a light being reported, the master will be justified in ordering the helm to be put to port, without exercising any discretion with regard to the position of the light as to his own course, or if it be a steamer, as to *which light*, whether the *green* or the *red*, is presented to his view.

It will be seen that the section limits the application of the rule to those cases only in which vessels are *meeting*, and which by standing on their respective courses will pass so near as to involve the risk of a collision. Therefore, when a vessel is reported, the master, or officer in charge of the deck, is to exercise his judgment as to whether the vessel is in such a position that *by continuing her course* she will risk a collision. The vessel, for instance, may be so broad on the bow that by standing on she would pass under the stern of the other vessel, (*see fig.* 3, p. 59,) and that by porting her helm in such a case would only incur danger. Again, a steamer's light may be reported a-head; it may be a *green*, or a *red* light,—and, according as the case may be, a blind adherence to the Port-helm would either involve, or avert collision. So that the application *of the rule to the case in point* must be always kept prominently in view; and a broad distinction must always be made between vessels which are *meeting* and those which are *crossing*—and the master who neglects to observe this distinction, and who *blindly gives the Port-helm* and brings about a collision, will,

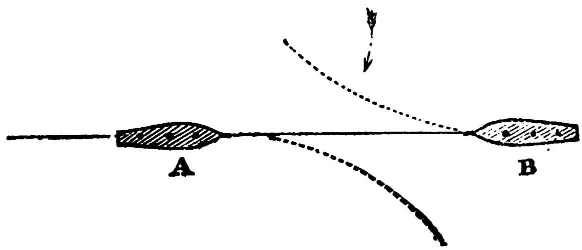
I conceive, be considered as having committed a breach of the rule, instead of having obeyed it, and would doubtless be judged accordingly.

I candidly admit the difficulty of defining in certain cases between *meeting* and *crossing*,—and as to whether, by standing on, vessels will actually encounter each other, especially with the present very imperfect night signals for sailing vessels; and this difficulty appears to have been foreseen by the framers of the Act, who have provided for the free exercise of the judgment of the master by giving a discretionary power to depart from the rule of the Port-helm, *when the circumstances of the cases are such* as to render a departure from the rule *necessary, in order to avoid immediate danger*, and in the penalty clause we find the master exonerated, should it be shewn to the satisfaction of the Court, that the circumstances of the case made a departure from the rule necessary.

The discretionary clauses are of great value, for while they provide against the difficulty of framing a simple and imperative rule of action for all circumstances, they have a tendency to promote caution on the part of the person in charge of the deck, and to check that disposition to indolence and carelessness, to which may be traced many of the collisions that happen in our seas.

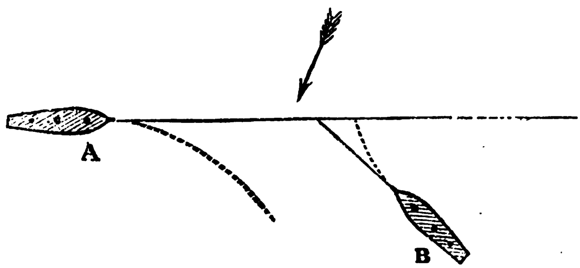
A few diagrams by way of illustration of what has been said, will probably be acceptable to our readers. In these diagrams I have supposed that a paddle-steamer, when going at full speed, on putting her helm down, will come round in a circle of which the diameter is about six times her own length: —if she slows her speed after the helm is down, she will come round in less,—and a screw-steamer will come round in much less.

The first and most simple case of the Port-helm is that of two vessels meeting. (*Fig.* 1.)



This is a clear case of *meeting*, and the Port-helm clears. It may also be given as an instance of the imperfection of the old rules, for both vessels are so near the wind, that they could not at night discover that their opponent was free, and if B imagined A to be on a wind she might give way, or starboard the helm, while A might also bear away, being on the port tack, and thus a collision would occur.

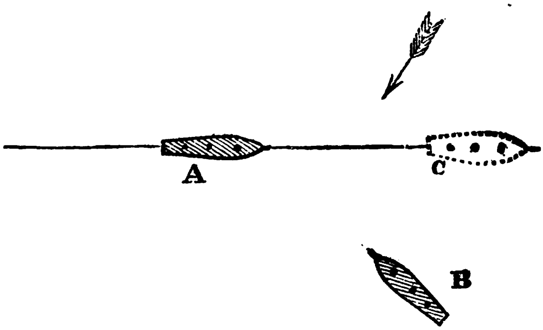
The next is a case of Port and Starboard tack. (*Fig.* 2)



By the Rule, A ports her helm, and B, if necessary, luffs or ports her helm, taking care to keep the vessel under command.

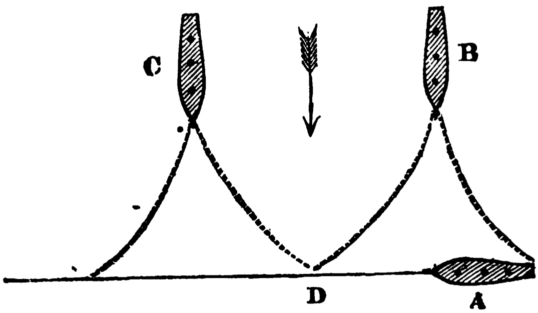
In the next figure (*Fig.* 3) A is so far a-head that she will have crossed the track of B, and reached the dotted ship C, before B reaches her, and a collision will not ensue. The vessels are clearly *not meeting* and they must not port their helms.

The position of these vessels, however, is one requiring



great caution, and both vessels must be prepared to act according to the circumstances of the case. A, especially, should be prepared to go about.

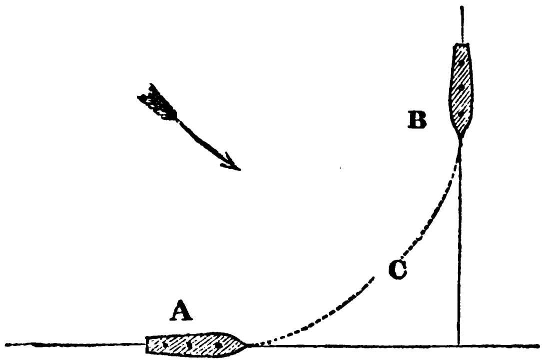
The next is an example of vessels *crossing.* (*Fig.* 4)



This is an illustration of the difficulty there would have been in framing a simple rule that would meet *all cases,* and of the necessity of leaving something to the discretion of the parties themselves. A, B, and C are crossing:—if the rule had been for *both* B and C either to port or to starboard their helms, or which would have been the same as regards the last case, to endeavour to pass under the stern of A,—B would have been in collision at about D by the first mentioned rule of the Port-helm, and C would have been in collision with A at D by the last-mentioned rule. So that no general rule could

in this case have avoided a collision with either one or the other of these vessels, and it is evidently a case that now comes under the discretionary part of the clause.

As I have heard various arguments in favour of a rule for vessels *when crossing,* by which they should be compelled to pass *under the stern of the vessel* they are approaching, I will trespass once more upon your time by another example of the impracticability of carrying out such a rule with safety. (*Fig.* 5.)



A is running with the wind on the Port quarter, and crossing the track of B, which is running with the wind on the starboard quarter. Both vessels would in such a case be bound to obey the rule, and endeavour to pass under the stern of the other. I am supposing this to be at night, when what the other vessel intended to do could not be readily perceived. It is clear that these vessels, in endeavouring to carry out such a rule, would be in risk of a collision at C.

I trust that these remarks by way of illustration of what is considered to be the true meaning of the Sections of the Act, may be of service to my brother seamen, but I beg to strongly urge upon them the necessity of keeping *a good look out,* and to be at all times ready to go about, or veer quickly, as the case may require, and to have a good light at hand,—for without these precautions, added to a due discrimination of circumstances, no rules, can be satisfactorily carried out.

LLOYD'S RULES

FOR THE

STOWAGE OF MIXED CARGOES,

Prepared by HENRY C. CHAPMAN & Co.
Agents for Lloyd's, Liverpool.

1.—Owners, Commanders, and Mates of ships, are considered in law in the same situation as common carriers, it is therefore necessary that all due precautions be taken to receive and stow cargoes in good order, and deliver the same in like good order. The law holds the ship-owner liable for the safe custody of the goods, when properly and legally received on board in good order, and for the "delivery," to parties producing the bill of lading. The captain's blank bill of lading should be receipted by the warehouse keeper, or person authorized to receive the contents. Goods are not unfrequently sent alongside in a damaged state, and letters of indemnity given to the captain by the shippers for signing in good order and condition; this is nothing more or less than conniving at fraud; fine goods are also often damaged in the ship's hold by lumpers, if permitted to use cotton hooks in handling bales. All goods must be received on board according to the custom of the port where the cargo is to be taken in; and the same custom will regulate the commencement of the responsibility of the master and owners.

2.—**Hemp, Flax, Wool,** and **Cotton,** should be dunnaged 9 inches on the floors, and to the *upper part* of the bilge, the wing bales of the second tier kept 6 inches off the side at the lower corner, and 2½ inches at the sides. Sand or damp gravel ballast to be covered with boards. Pumps to be frequently sounded and attended to. *Sharp bottomed ships one-third more dunnage in floor and bilges.* Avoid Horn Shavings as dunnage from Calcutta.

3.—All **Corn, Wheat, Rice, Peas, Beans,** &c. when in bulk, to be stowed on a good high platform, or dunnage wood, of not less than 10 inches, and in the bilge 14 inches dunnage; the pumps and masts cased, to have strong bulkheads, good shifting boards, with feeders and ventilators, and to have no admixture of other goods. Flat-floored, wall sided ships should be fitted with bilge pumps. On no consideration must the staunchions under the beams be removed.

4.—**Oil, Wine, Spirits, Beer, Molasses, Tar,** &c. to be stowed bung up; to have good *cross-beds* at the quarters, (*and not to trust to hanging beds,*) to be well chocked with wood, and allowed to stow three heights of pipes or butts, four heights of puncheons, and six heights of hogsheads or half-puncheons. All Moist Goods and Liquids, such as **Salted Hides,** Bales of **Bacon, Butter, Lard, Grease, Castor Oil,** &c. should not be stowed too near "Dry Goods," whose nature is to absorb moisture. Ship-owners have often to pay heavy damages for leakage in casks of Molasses, arising from stowing too many heights without an intervening platform or 'twixt decks. From Bengal, goods also are frequently damaged by Castor Oil.

5.—**Tea** and **Flour,** in barrels,—**Flax, Clover,** and **Linseed** or **Rice,** in teirces,—**Coffee** and **Cocoa,** in bags, should always have 9 inches, at least, of good dunnage in the bottom, and 14 to the upper part of the bilges, with 2½ inches at the sides; allowed to stow six heights of tierces, and eight heights of barrels. All ships above 600 tons should have 'twixt decks or platforms laid for these cargoes, to ease the pressure; caulked 'twixt decks should have scuppers in the sides, and 2½ inches of dunnage laid athwart ship, and not fore-and-aft ways, when in bags or sacks: and when in boxes or casks not less than 1 inch. **Rice,** from Calcutta, is not unfrequently damaged by Indigo, for want of care in stowing.

6.—Entire cargoes of **Sugar, Saltpetre,** and **Guano,** in bags, must have the dunnage carefully attended to, as laid down for other goods. **Timber** ships are better without 'twixt decks if loading all Timber or Deals. Brown Sugar to be kept separate from White Sugar, and both kept from direct contact with Saltpetre.

7.—Pot and Pearl **Ashes, Tobacco, Bark, Indigo, Madders, Gum,** &c. whether in casks, cases or bales, to be dunnaged in the bottom, and to the upper part of the bilges, at *least* 9 inches, and 2½ inches at the sides.

8.—**Miscellaneous Goods,** such as boxes of **Cheese,** kegs and tubs of **Lard,** or other small or slight made packages not intended for broken stowage, should be stowed by themselves, and dunnaged as other goods.

9.—**Barrels of Provisions** and **Tallow** casks, allowed to stow six heights. All **Metals** should be stowed under, and separated from, goods liable to be damaged by contact.

10.—All **Manufactured Goods,** also **Dry Hides,** bales of **Silk,** or other valuable articles, should have 2½ inches of dunnage against the side, to preserve a water course. Bundles of **Sheet Iron, Rods, Pigs** of **Copper** or **Iron,** or any rough hard substance, should not be allowed to come in contact with bales or bags, or any soft Packages liable to be chafed. When mats can be procured, they should be used at the sides for Silk, Tea, &c.

11.—**Tar, Turpentine, Rosin,** &c. to have flat beds of wood under the quarters, of an inch thick, and allowed to stow six heights.

12.—Very frequent and serious loss falls on Merchants on the upper part of cargoes, particularly in vessels that bring Wheat, Corn, Tobacco, Oil Cake, &c. arising from vapour-damage imbibed by Wheat, Flour, or other goods, stowed in the same vessel with Turpentine, or other strong-scented

articles: the shippers are to blame for such negligence, for not making due inquiry before shipping.

13.—Ships laden with full cargoes of Coal, bound round Cape Horn or Cape of Good Hope, to be provided with approved ventilators, as a preventive against ignition.

14.—No vessel bound on any over-sea voyage, should on any account be loaded beyond that point of immersion which will present a clear side out of water, when upright, of three inches to every foot depth of hold, measured amidships, from height of the deck at the side, to the water.

Note.—Shippers abroad, when they know that their cargoes will be stowed properly, will give a preference and at higher rates, to such commanders of ships as will undertake to guarantee the dunnage. The American ship-owners, in the stowage of mixed cargoes in large ships, have, from experience, discovered what "pressure" flour barrels, provision casks, &c. will bear, and so avoid reclamations for damage, if otherwise properly stowed: hence, in large ships above 600 tons, with dimensions exceeding in length 4½ times the beam, and 21 feet depth of hold, orlop decks will come into general use, so as to relieve the pressure, by dividing a ship's hold, like a warehouse in stories. A large ship, called the Liverpool, which left New York with an entire cargo of flour, has never since been heard of; it is supposed the lower tiers of barrels gave way under the pressure, and the cargo having got loose, shifted in a gale of wind, and capsized the vessel.

Ship's cargoes, for Insurance, will also become a matter of special agreement between merchant and Ship-owner, and merchant underwriters, and the premium vary according to the dunnage agreement. The stowage and dunnage must stand A 1, and is often of more importance than the class of the vessel, as experience has proved. When ships are char-

tered for a lump sum the draft of water should be limited, as it not unfrequently happens that brokers insert a clause that coals are not to be considered as dead weight, in order to fill the ship up in case of goods falling short to make up the chartered freight. All packages, bales, and cases, not weighing more than 25 cwt. to the cubic ton measurement, are designated light freight.

Bale Goods should be stowed on their *flats* in midships, on their *edges* in the wings. In a general cargo, the Dry Goods should be stowed in the after-part of the ship.

Bar Iron should be stowed diagonally (or grating-fashion) bringing it up like a pyramid FROM THE ENDS, stowed in this way it is not such a dead weight in the ship.

LEADING LIGHTS OF THE ENGLISH CHANNEL

On the English Coast.

N.B.—The Light is bright unless otherwise specified.

Name of Lights.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Scilly Isles, Bishop Rock....		F.			Building.
St. Agnes	1	R.	Every minute	16	
Seven Stones ...... Light Vessel.	2	F.	. .	10	A gong is sounded during foggy weather.
Longships	1	F.	. .	14	When in one, they lead clear of the Manacles to the E. and of the Wolf to the W,
Lizard	2	F.	. .	20	
Eddystone	1	F.	. .	13	
Start Point	1	R.	Brilliant flash every minute.	19	A fixed light is also shewn in the direction of Berry Head visible only when the Start Point bears to the Southward of W. S. W.
Portland	2	F.	. .	19 / 16	When in one, they lead between the Race and Shambles.
Needles .... Removed to the outer rock.	1	F.	. .	27	Red sea-ward; bright towards Hurst Point.

Name of Light.	Number of Lights	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Calshot	1	R.			
Bembridge or Nab, Light Vessel	2	F.	. .	8 / 10	A gong is sounded during foggy weather.
St. Catherine. Isle of Wight......	1	F.	. .	18	
Owers.............. Light Vessel	1	F.	. .	10	A gong is sounded during foggy weather. When a vessel is standing into danger a gun is fired.
Beachy Head	1	R.	Two minutes; duration of flash 15 seconds.	22	Kept open of the next Eastern Cliff, leads outside the Royal Sovereign and the other shoals.
Dungeness.........	1	F.	. .	14	
South Foreland ...	2	F.	. .	22 / 25	These lights in one, clear the South end of the Goodwin Sands. Off Folkestone, stand off shore when the high light disappears.)
South Sand Head. Light Vessel	1	F.	. .	10	A gong is sounded during foggy weather.
Gulf Stream ...... Light Vessel	2	F.	. .	7	A gong is sounded during foggy weather.
North Sand Head. Light Vessel	3	F. triangular.	. . .	10	A gong is sounded during foggy weather.
North Foreland ...	1	F.	. .	18	

On the French Coast.

Dunkerque	1	R.	Every minute.	24	
Gravelines.........	1	F.	. .	15	
Calais...............	1	F.	Varied by a flash every four minutes.	21	

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash	Miles. seen in clear Weather.	Remarks.
Cape Grisnez......	1	R.	Every half minute.	22	
Ailly	1	R.	In 80 seconds.	18	
Fecamp	1	F.	. .	18	
La Heve	2	F.	. .	20	
Point de Ver	1	F.	. .	15	Varied by a flash every four minutes
Cape Barfleur ...	1	R.	Every half minute.	22	With the distance of 12 miles the light does not quite disappear.
Cape de la Hague,	1	F.	. .	18	
Cape Carteret ...	1	R.	Every half minute.	18	
Casquets	3	R.	Every 15 seconds.	15	All visible at the same time. A bell is tolled during foggy weather.
Chansey	1	F.	. .	15	Bright, varied by red flashes every four minutes.
Granville	1	F.	. .	15	
Cape Frehel	1	R.	Every half minute.	22	
Héaux de Bréhat.	1	F.	. .	18	
Ile de Bas	1	R.	Every minute.	24	
Ile Viérge	1	F.	. .	15	Bright, varied by red flash every four minutes.
Ushant	1	F.	. .	18	

LEADING LIGHTS OF ST. GEORGE'S CHANNEL FOR DUBLIN AND LIVERPOOL.

South, East, and North Coasts of Ireland.

Name of Light.	Number of Lights	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Fastnet Rock... ..	1	R.	Every two minutes	18	Instead of that formerly shewn on Cape Clear. A rock carrying 11 feet at low water, 400 yards E.N.E. of the Fastnet.
Kinsale, Old Head	1	F.	. .	22	
Cork, Roche Pt...	1	F.	. .	14	Red to seaward.
Ballycottin	1	R.	Every 10 seconds	18	
Minehead	1	R.	Every minute.	21	Bright 50 seconds; suddenly eclipsed 10 seconds. Visible from E. N. E. ¼ N. to W. ¾ S.
Hook Tower	1	F.	. .	16	
Saltees .... Light Vessel	2	F.	. .	9	During foggy weather a bell is tolled.
Coningberg Rock.	1	F.	. .	. .	Building.
Tuskar	1	R.	Every two minutes.	15	During foggy weather a bell is tolled every half minute. Two sides bright, one red.
Arklow .... Light Vessel	1	F.	. .	9	During foggy weather a bell is tolled.
Wicklow Head ...	2	F.	. .	21 16	When in one, they lead between the India and Arklow banks.
DUBLIN BAY,					
Kish .... Light Vessel	3	F.	. .	9	During foggy weather a bell is tolled.
Poolbeg	2 1	F. F.	. . . .	12 10	End of S. wall. End of N. wall.
Bailey............	1	F.	. .	15	In foggy weather a bell is tolled.
Howth	1	F.	Red light.	. .	Two small lights on W. Pierhead serve as a leading mark going in from Northward, or from between Ireland's Eye and Lambay.
Carlingford ...... Haulbowline Rock	2	F.	. .	15	In foggy weather a bell is tolled.
Dundrum Bay ... St. John's Point	1	R.	Every minute.	. .	
South Rock	1	R.	Every minute and half.	12	

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Copeland	1	F.	. .	16	
Maidens	2	F.	. .	14 13	
Rathlin............	1	. .	. .	. .	Building
Innistrahull	1	R.	Every two minutes.	18	
Lough Swilly ...	1	F.	. .	14	Red; towards the Lough, Bright
Tory Island ...	1	F.	. .	16	
Rathlin O-Birne.	1				

Welsh and Scotch Coasts, including the Isle of Man.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Smalls	1	F.	. .	13	
South Bishop ...	1	R.	Every 20 seconds.	17	
Bardsey	1	F.	. .	17	
Stack	1	R.	Every $1\frac{1}{2}$ minutes.	19	During foggy weather a smaller light is occasionally shewn, 30 yards N. of the main Light-house.
Skerries	1	F.	. .	15	
Lynus...............	1	R.	Ten seconds; visible 8 seconds, obscured 2s	16	
Entrance to Mersey and Dee Rivers.					
Air	1	F.	. .	10	A bell is sounded in foggy weather. From N.W. to W. bright; from N.W. to E.b.S $\frac{1}{4}$ S. red; from E.b. S. $\frac{1}{4}$S. to E. bright; red light visible only within the Hoyle Sand.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Liverpool, North west Light Ship	3	F.	. .	10	A bell is tolled during fogs.
Bidstone.........	1	F.	. .	23	
Leasowe.........	1	F.	. .	15	
Rock	1	R.	Every minute.	14	Bright twice, then Red once, every third minute. A bell is tolled during foggy weather.
Formby .... Light Vessel	2	F.	. .	8	
Formby	1	F.			
ISLE OF MAN,					
Bahama Bank . Light Vessel	2	F.	. .	10	A gong is sounded during foggy weather.
Douglas, on the Head	1	F.	. .	. .	
Calf of Man ...	2	R.	Every two minutes.	22 24	
Ayre	1	R.	Every two minutes.	15	Bright and Red alternately.
Mull of Galloway.	1	R.	Every 3 minutes 2½ visible and half minute eclipsed.	23	
Corsewall	1	R.	Every 2 minutes	15	Bright and Red alternately.
Sanda Island	1	F.	. .	15	Red.
Mull of Cantyre...	1	F.	. .	22	
Rhins of Ila	1	R.	Every five seconds.	17	

LEADING LIGHTS OF THE BRISTOL CHANNEL.

Name of Light.	Number of Lights.	Fixed or Revolving	Interval of Revolution or Flash.	Miles seen in clear Weather.	Remarks.
Lundy	2	Upper R. Lower F.	Every two minutes.	30	Low light only visible from the westward, between N. by W. and S. W.
Flatholm	1	F.	. .	17	
Usk	1	F.	. .	10	
Nash	2	F.	. .	18 16	When in one, leading a cable's length S. of Nash Sand.
Mumbles	1	F.	. .	15	
Helwick .... Light Vessel	1	R.	Every minute.	10	A gong is sounded in foggy weather.
Caldy...............	1	F.	. .	19	Part bright, part red. The E. limit of the red light, clears the W. end of the Helwicks, bearing S. E. by S. distant 13 miles
St. Ann's	2	F.	. .	19 17	When in one, they lead clear of the Crow and Toes Rocks.

CHARTER-PARTY.

Charter-party is a contract by which a ship or part of a ship is hired for the conveyance of goods, on certain specified conditions. It is not required to be drawn up in any precise form of words, for, as ships may be engaged under a great variety of circumstances, and on voyages of very different characters, and as there are frequently peculiar regulations and customs attached to certain trades, so there must be a corresponding diversity in the forms of charter-parties, which are necessarily adapted to suit the wishes and intentions of the parties concerned, and the trade in which the vessels are to be employed.

A charter-party settles the terms on which the cargo is to be carried, and specifies the nature of the voyage: the owners (or agent, or master, as the case may be) usually covenant to provide a ship strong, staunch, and in every respect, seaworthy; well and sufficiently found in sails, sailyards, anchors, cables, ropes, &c. and other instruments, tackle, apparel, furniture, provision, &c. needful and necessary for such a ship, and for the given voyage, together with an able master and a sufficient number of mariners;—binding themselves also, that the cargo shall be delivered (the perils and dangers of the seas excepted) well-conditioned, and with as much speed as may be, at the place of discharge agreed upon: the merchant or freighter stipulates to comply with the payment promised for freight, according to the terms of the contract: and both parties bind themselves in penalties for non-performance of the covenants, articles, and agreements in the charter-party: it is signed by the contracting parties and a witness.

In a vessel's *home* port, the charter-party is executed by

the owner or owners, and the freighter or his agent; but in a *foreign* port, it is executed by the master, or the owner's authorized agent (if there be such), and the freighter or his agent.

A charter-party executed by the master, at home, under the evidence of the expressed or implied assent of the owner—or when in a foreign port, and there is no evidence of fraud, is binding on the owner.

A charterer may load the vessel with his own goods, or with those of other parties; or he may underlet the vessel to another, provided no clause in the charter-party prohibits him so doing.

The owners are bound to prepare and furnish everything necessary to commence and fulfil the voyage. The ship must also be properly dunnaged, according to the usages of the trade in which she is employed, or according to the nature of the cargo: and in stowing the cargo, the various goods must be arranged and placed in the most approved methods, to prevent damage.

Expedition is of the utmost importance in all commercial and maritime transactions;—if, therefore, either party be not ready, at the specified time, for the loading of the ship, the other is at liberty to seek another ship or cargo, and bring an action to recover the damages he has sustained by the non-performance of the contract.

If the charter-party specifies any particular route, or names several ports, and the order in which they are to be taken, the master must pursue that course; but without such special mention, they must be taken in geographical order, on the usual or shortest course. A deviation from the prescribed or usual course is justifiable for the purpose of repairs rendered necessary by tempests or accidents, to procure supplies, or to avoid an enemy; but the vessel must be detained

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no longer than is absolutely requisite, and the voyage afterwards continued from the port in which she has taken refuge.

For the purpose of loading and unloading the ship, a certain number of days, called *lay days*, are generally agreed upon; it should be specified whether these are working or running days; and in addition it may be stipulated, that the freighter is at liberty to detain the vessel a further fixed time, on payment of a daily sum, as *demurrage*. Should the vessel be detained beyond both periods, the freighter is liable to an action for damages, although the delay may not be attributable to any fault on his part.

When no *lay days* are specified, the length of time for loading and unloading must be determined by the nature of the cargo, or the number of days usually allowed at the port.

As soon as the vessel has the full complement of cargo, and all things necessary are arranged, as clearing at the custom house, payment of port charges, &c. the voyage must be forthwith commenced, *weather* permitting.

The master must not take on board any contraband goods, or have in his possession any false or colourable papers whereby the ship and cargo are rendered liable to seizure; but he must obtain all papers and documents which are necessary to protect the ship and cargo in all the countries to which he is trading.

In time of war, if there is any stipulation to sail with convoy, the master must repair to the place of rendezvous, in good time, and be careful to procure all the instructions issued by the commander of the convoy, as he is accounted answerable for losses brought about by neglect in such a case.

By the terms of the charter-party, not to be held liable for injuries arising from "the act of God, and the Queen's enemies, &c." the master or owner is not responsible for

damage arising from the sea and winds, unless such injury or damage was the result of negligence or imprudence.

If the master receive goods at the sea or beach, or send his boat for them, his responsibiliry commences with the *receipt* of them. With goods to be sent coastwise, the responsibility of the wharfinger ceases on delivering them upon the wharf.

When the charter-party names a full and complete cargo, the master must take on board as much as he can, with safety, and without injury to the ship; and the freighter is obliged to furnish the same, either of his own goods, or the goods of others.

If any clause of the charter-party is ambiguous, the interpretation should be liberal: or if the charter-party is silent in respect to any point, the usage of the trade in which the ship is employed must be adopted.

In the case of a vessel having, by the terms of the charter-party, to proceed to a foreign port, the merchants covenanting to furnish a lading there, and being arrived, if the contracting parties or their agents are unwilling or unable to furnish a cargo,—on the expiration of the lay days, the master must note a protest against the merchants for non-fulfilment of the charter-party, after which he may seek a freight in another direction.

A prohibition of the government of that country to export the proposed articles, neither dissolves the contract, nor excuses the non-performance of it.

It is customary for the master, before delivering the cargo, and within 24 hours after his arrival in port, to cause a notary-public to note a protest "against wind and weather," as the term is,—giving the particulars of the voyage,—the

storms or gales encountered,—protesting that any damage that may have occurred was caused by winds, bad weather, &c.

An instrument of protest can be extended in the proper form when the nature and amount of damage is ascertained. If a survey has been called, which in a foreign port should consist of two masters of vessels, the survey-report must particularize the goods damaged, mentioning their marks, numbers, &c. and being signed, must be given to the master of the vessel.

FREIGHT.

Freight is the sum paid by any merchant or other person hiring a ship or part of a ship, for the hire of such ship or part, during a specified voyage, or for a certain fixed time.

Freight may be contracted to be paid by the voyage, by the month or other time, or by the ton, and is usually fixed by the charter-party, or bill of lading: where no formal stipulations have been made, it would be due according to the custom of the trade in which the ship is employed.

As a general rule, no freight is due, unless the voyage has been performed, and the goods delivered at the port of destination, according to the contract: but with respect to living animals, men or cattle, which may die on a voyage, it is ruled that freight is due for dead or living, if no stipulation has been made in respect to them; if however, the contract is for transporting them, no freight is due for those dying on the voyage, as the contract is not performed; on the other hand, if the agreement is for the *lading*, then freight is due for dead and living.

If the whole ship is hired, and the freight is to be paid as a gross sum, the whole freight is due, although the freighter does not fully load the ship: or when the freight is to be paid at so much per ton, and the contract is for a full cargo, freight will be according to the *real burden* of the ship, although there may have been an error in the contract in describing the ship of less burden than she really is.

When freight is to be paid at a fixed sum for the whole voyage, the owners take on themselves the chance of the voyage being long or short; but when the freight is to be paid at so much per month or week of the voyage, the risk of the duration falls on the freighter, who must pay for the whole time occupied, commencing from the day the vessel, breaks ground, (whatever obstructions or delays may afterwards occur, provided they are not occasioned by the neglect or fault of the owners or master,) until she arrive at the port of destination.

If freight is stipulated to be paid only on delivery of the cargo, this must take place before the freight can be demanded.

If by the charter-party a ship is to sail from one port to another, and thence back to the first, the whole being one voyage, no freight is due unless the whole voyage has been performed, although the ship might have delivered her cargo at one port, and she is only lost on returning to the place whence she started; but if the outward and homeward voyages are distinct, and the first only is performed, the ship being lost on the homeward voyage, freight is due for the first.

If the cargo or any portion of it is damaged, through the fault or negligence of the master or crew, the charterer is entitled to compensation, being the amount of depreciation in the value of the goods, less freight; if, however, the

damage arises from circumstances over which the master has no control, freight is due, and compensation for damage is allowed.

The right of a merchant to abandon his goods for freight, when they have been damaged, has never been claimed in Great Britain: no freight is due in the event of a total loss.

If a portion of a cargo has been thrown overboard for the preservation of a ship, and she afterwards arrive at the port of destination, the value of the rejected cargo is to be answered to the charterer by way of general average, and the value of the freight thereof allowed to the owner. If the master is compelled to sell a part of the cargo for supplies or repairs, the owner must pay to the merchant the market price the goods would have brought at the place of destination.

If it is found that the ship is disabled and cannot proceed to the port of destination, and the master declines to tranship the cargo, and the merchant does not require him to do this, but accepts the goods at the intermediate port, then freight is due according to the proportion of the voyage performed; if the master provides another ship for the transmission of the goods, he will be entitled to the whole freight originally contracted for, although by the second conveyance the goods may be carried for less than that freight; if the freighter will not consent to the goods being forwarded, the master being ready to do so, he will be liable for the full freight of the whole voyage.

If a consignee receive goods in accordance with the usual bill of lading, he is liable for the freight; but a person acting as *agent* for the consigner, it being known to the master that he acts in that capacity, is not liable.

If a ship under a charter-party, is sold *before* the voyage commences, the purchaser is entitled to the charter, but if a

vessel is sold *during* a voyage, the original owner is entitled to it.

When the time and manner of paying freight is mentioned in the charter-party, or in any other written contract, the stipulations must be respected.

A master cannot retain the cargo on board until the freight is paid.

BILLS OF LADING.

A Bill of Lading is a formal receipt signed by the master of a ship, acknowledging that he has received on board, the goods specified on it, and binding himself (under certain exceptions,) to deliver them in like good order as received, at the place and to the individual named in the bill, on the payment of the stipulated freight. The terms of the exceptions above mentioned, are as follows:—" the act of God, the Queen's enemies, fire and all and every other dangers and accidents of the seas, rivers and navigation, of whatever nature and kind soever excepted," and in the case of ships homeward bound from the West Indies, which send their boats to fetch the cargo, there is further added, " save risk of boats, so far as ships are liable thereto."

The Bills of lading determine the contents of the cargo of a ship.

The master should not sign bills of lading, until the goods are delivered, and on board, and he is satisfied of their condition.

When a ship is hired by a charter-party, the bills of lading are delivered by the master to the person to whom the ship is

chartered, but in a *General* ship, (*i.e.* a ship in which goods of many different parties are laden,) each person sending goods on board, receives a bill of lading for the same.

It is usual to make out three bills of lading, each of which must be stamped: one for the shipper, another for the consignee or agent, or purchaser, (this is sent by post,) and the third is retained by the master for his use and guidance.

Bills of lading are transferable by indorsation, and the master must deliver the goods to the holder of the bill who has acquired a legal right to it.

INVOICE.

An Invoice is a description of goods sold or consigned, with an account of the cost and charges. A shipping or exportation invoice gives an account of the goods, the name of the vessel and of the master, the port of destination, the name of the consignee; the description of goods with the cost and charges, and a specification of the account on which the goods are sent.

MANIFEST.

A Manifest is a document signed by the master at the place of lading, and sets forth the name and tonnage of the ship, the name of the master and of the place to which the ship belongs—of the place or places where the goods are shipped—and the place or places for which they are respectively destined; it must give a particular account and

description of all packages on board, with the marks and numbers thereon, the sorts of goods, the different kinds of each sort, to the best of the master's knowledge, particulars of goods stowed loose, also a recapitulation of the total number of the packages of each sort, describing them by the names by which they are best known, the names of shippers and consignees, and all other particulars relating to the ship, her cargo, and her passengers.

BOTTOMRY.—RESPONDENTIA.

Bottomry is the mortgaging of a ship; a bond whereby the ship's *bottom* is pledged as a security for the repayment of money borrowed to carry on the voyage: the money advanced, together with the premium or interest, becomes repayable on the ship terminating the voyage successfully, the vessel as well as thc borrower being then liable for the money lent.

If the ship is lost, the lender loses the whole money, and since he has to sustain the hazard of the voyage, he is allowed a greater interest or premium than the usual rate acknowledged by law. Money thus obtained must be expended in refitting and repairing the ship.

Money is said to be taken on respondentia, when the loan is not on the vessel but on the cargo, and the lender must be paid principal and interest although the ship is lost, provided the goods are saved.

If, on a voyage, two or more bottomry bonds be entered into, they take precedence in the reverse order, the last being first payable.

Money to be borrowed on bottomry, should always be advertised for, and the lowest offer of interest accepted.

THE OFFICIAL LOG BOOK.

As every master of a vessel must possess the Official Log Book, it is unnecessary to say anything on the manner of using it, an accurate knowledge of which can only be acquired by inspecting the various columns it contains, and ample directions are given in the first pages for this purpose. All entries must be carefully made and particular attention is required as to the instructions relating to "*Entries of Offences to be read over,*" and "*Entries of Wages and Effects of Deceased Seamen.*"

EXAMINATION FOR MASTER EXTRA.

THE VERIFICATION OF THE LATITUDE BY DOUBLE ALTITUDES OF THE SUN.

SUMNER'S METHOD.

1. Find the Greenwich date of *each* observation.
2. From the Nautical Almanac find the Sun's Declination for each date.
3. From the observed find the true altitudes as in the usual method of double altitudes.
4. Select two latitudes, one of which is the degree (without odd minutes) *less*, and the other the next degree *greater* than the latitude by dead reckoning. Or, assume two latitudes from 5′ to 30′ on each side of the approximate latitude, such that there may be a difference of from 10′ to 1° between the two latitudes thus chosen.
5. Find the apparent time from noon in each of the following cases:
   (*a.*) With the first altitude, the corresponding declination and less latitude.
   (*b.*) With the second altitude, the corresponding declination, and less latitude.
   (*c.*) With the first altitude, the corresponding declination and greater latitude.
   (*d.*) With the second altitude, the corresponding declination and greater latitude.

6. Obtain the *elapsed time* corresponding to *each assumed latitude* thus:—If one observation be A.M. and the other P.M. take the sum of the times (hour angle) found by (*a*) and (*b*): if both be A.M. or both P.M. take the difference of the results of (*a*) and (*b*); call this sum or difference the *elapsed time* (*e*) *for that assumed latitude.* Proceed in the same manner, using the results of (*c*) and (*d*) to find the *elapsed time* (*f*) *for the other assumed latitude.*

7. Take the difference of elapsed time (*e*) for the one assumed latitude and the *true* apparent elapsed time, calling the remainder *too little* if the former is less than the latter, but *too much* if the reverse is the case. Find also the difference of the elapsed time (*f*) for the other assumed latitude and the *true* apparent time, naming the remainder on the same principle as before.

8. When *one* elapsed time is *too much* and the *other too little* take their sum,—but if *both* are *too much*, or *both too little*, take their *difference* for the error of elapsed time caused by an error of 10′ 20′ 40′ or 1° of latitude, according to what has been assumed.

Lastly, make this proportion which can be computed by proportional logarithms:

As the error of elapsed time on the diff. of assumed latitude, prop. log. (ar. co. .... +
Is to 10′ 20′ 40′ or 1° as the case may be ...... +
So is the error of elapsed time for the less or greater assumed latitude........................ +

To a correction to be applied to that assumed latitude..............(.) prop. log.

It will be at once seen that when the elapsed time of one assumed latitude is *too little* and that of the other *too much*, the *true* latitude is between the two assumed latitudes, consequently the correction must be added to the less or subtracted from

the greater assumed latitude, according to which is used for determining of the correction. But, *both* the elapsed times of the two assumed latitudes may be *too much* or *both too little*,—(each case is possible;) then the correction must be applied to satisfy the following condition; if the elapsed time of the less assumed latitude differs from the true elapsed time by a given quantity, and that of the greater assumed latitude by a less quantity, then the true latitude must be greater than the greater assumed latitude; also if the elapsed time of the greater assumed latitude differs from the true elapsed time by a given quantity, and that of the less assumed latitude by a less quantity, then the true latitude must be less than the less assumed latitude.

Example 1.—July 24, 1861: the following observations were made for latitude by double altitudes,

app. time at ship	23^d	21^h	48^m	30^h	1st true alt ⊙'s l.l	$50°$	$40'$	$18''$	bearing S. E. ¾E.
„	„	24	0	58	10	2nd „	„	58	14	18	

course and distance in the interval N.14′: lat. by account 49° 22′N.: long. 39° 45′W.: required the latitude.

App. time, July 23^d	21^h	48^m	30^s	July 24^d	0^h	58^m	10^s
long.	2	39	0		2	39	0
Greenwich time ...		27	30		3	37	0

⊙'s 1st dec. cor. 19° 50′ 17″

⊙'s 2nd cor. dec. 19° 48′ 36″ cor. for position 8′ 18″

1st alt. ...	50°	32″	0″			1st alt. ...	50°	32′	0″	
1st p. d...	70	9	43	cosec..	0·02657	1st p. d...	70	9	43	.... 0·02657
lat..........	49	0	0	sec. ...	0·18306	lat.........	49	40	0	.... 0·18894
	84	50	51	cos. ...	8·95331		85	10	51	.... 8·92434
	34	18	51	sin. ...	9·75107		34	38	51	.... 9·75475
(*a*)...	2	13	9	....	8·91401	(*c*)...	2^h	10^m	8^s	.... 8·89460

2nd alt....	58°	14′	18″		2nd alt ...	58°	14′	18″	
2nd p. d. .	70	11	24	.... 0·02649	2nd p.d...	70	11	24	.... 0·02649
lat...	49	0	0	.... 0·18306	lat...	49	40	0	.... 0·18894
	88	42	51	.... 8·35102		89	2	51	.... 8·22071
	30	28	33	.... 9·70515		30	48	33	.... 9·70941
(b)...	1h	2m	26s	hour ∠ 8·26572	(d)...		54m	19s	hour ∠ 8·14555
(a)...	2	13	9		(c) ...	2	10	8	
1st elaps. t.	3	15	35		2nd elaps. t.	3	4	27	
true elap. t.	3	9	40		true elap. t.	3	9	40	
		5′	55 too much				5	13 too little	
		5	13 too little						

Hence, as 11 8 : 40′ :: 5′ 55″ : 21′ 15″ + 49° = 49° 21′ 15″N. Latitude.

Example 2.—Sept. 20, 1861 : the following observations may be supposed to have been made for latitude by double altitudes,

app. time at ship 1h 0m 20s P.M. true and cor. alt. ☉'s l.l. 55° 48′ bearing N.14°W.
app. time at ship 4 5 20 P.M. true alt. and cor. ☉'s l.l. 24° 1′

ship's course and distance in the interval N.8′ : lat. by acc. 30° 1′S. : long. 9° 45′E. : required the latitude.

app. t. at ship, Sept. 20...	1h	0m	20s	Sept. 20	4h	5m	20s
long.		39	0			39	0
Greenwich date		21	20		3	26	20

cor. for position... + 7′ 48″

1st dec. 1° 0′ 18″ − 21″ = p. d. 91°   2nd dec. 1° 0′ 18″ − 3′ 21″ = 90° 57′ p. d.

1st alt.	55°	48′		1st alt.	55°	48′	
1st p. d.........	91	0	.... 0·00007	1st p. d.........	91	0	cosec. . 0 00007
latitude	29	42	.... 0·06116	latitude.........	30	22	sec. ... 0·06409
	88	15	.... 8·48485		88	35	cos. ... 8·39310
	32	27	.... 9·72962		32	47	sin. ... 9·73357
(a)......	1h 3m	9s	.... 8·27570	(c).........	57m	15s	.... 8·19083

2nd alt.........	24° 1′			2nd alt...	24° 1′		
2nd p. d.	90 57	....	0·00006	2nd p. d.	90 57	....	0·00006
latitude.........	29 42	....	0·06116	latitude.........	30 22	....	0·06409
	72 20	....	9·48213		72 40	....	9·47411
	48 19	....	9 87322		48 39	....	9 87446
(b) ...	4^h 5^m 46^s	hour ∠	9·41657	(d)...	4^h 4^m 52^s	hour ∠	9·41372
(a) ...	1 3 9			(c)...	57 15		
	3 2 37	1st elaps. time			3 7 37		
	3 5 0	true elaps. time			3 5 0		
	2 23	too little			2 37	too much	
	2 37	too much					

As 5 0 : 40′ :: 2′ 23″ : 18′ 56″ + 29° 42′ = 30° 0′ 56″S. Latitude.

Rule for correcting the Latitude for the change of Declination in the half elapsed time (double altitudes.)

To the sine of arc 2,* add the secant of the lat., the log. of the change of declination in the half elapsed time, reduced to seconds, and the co-secant of the half elapsed time, the sum, rejecting tens, is the log. of the correction.

If the second altitude is the less, and the days shortening, the cor. for lat. is +. If either condition is reversed, the cor. is —. If both are reversed, the sign remains +.

* Ivory's method.

Paper I.

1. Jan. 14, 1861: long. 39° 42′W.: observed meridian altitude ☾ 60° 0′ 15″: index error —1′ 18″: eye 19 feet: ☾ S. of observer: required the latitude.

2. Jan. 18, 1861: at 7^h 15^m 35^s P.M. mean time at ship: long. 168° 40′E.: the observed altitude of Polaris off the meridian being 45° 10′ 40″: eye 21 feet, required the latitude.

3. Jan. 31; 1861: the following double altitude of the sun was observed:

app. time at ship.	obs. alt. ☉'s l.l.	
8^h 15^m 56^s A.M.	20° 6′ 46″	bearing S. 58°E.
11 8 36 A.M.	44 28 31	

eye 20 feet: course and distance in the interval N. 42° E. 32 miles: lat. by account 26° 11′N.: long. 126° 45′E.: required the true latitude when the second observation was made.

4. Verify No. 3 by Sumner's method.

5. March 2, 1861: lat. 16° 54′N.: long. 25° 22′W.: equal altitudes of ☉ were taken, when the corresponding times by chronometer were 10^h 10^m 4^s A.M. and 3^h 56^m 14^s P.M. to determine the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. Jan. 13, 1861: P.M. at ship: lat. 40° 36′S.: time by chronometer 13^d 6^h 19^m 14^s, which was supposed to be 1^m 28^s slow on mean time at Greenwich:

	obs. alt. ☉ l.l.	obs. alt. ☾ u.l.	obs. dist. n.ls.
	35° 29′ 50″	17° 45′ 0″	30° 48′ 0″
index error	+ 1 36	+ 1 26	— 37

eye 21 feet: required the longitude and error of the chronometer on mean time at Greenwich, by lunar observation.

7. Jan. 24, 1861: the observed altitude of the ☉ by the artificial horizon being 86° 0′ 4″: index error —1′ 18″: required the true altitude of ☉'s centre.

8. A ship by dead reckoning has made N. 30°W. 105 miles, but by observation it is found to have made N. 20°W. 101 miles, required the set and drift of the current.

Paper II.

1. Feb. 19, 1861; P.M. at ship: long. 64° 9′W.: observed meridian altitude ☾ 49° 30′ 10″S.: index error —1′ 18″: eye 18 feet: required the latitude.

2. March 20, 1861: at 7^h 17^m P.M. mean time at ship: long. 19° 56′W.: the observed altitude of Polaris off the meridian being 54° 50′ 40″: index error + 1′ 10″: eye 23 feet: required the latitude.

3. April 2, 1861: the following double altitude of the sun was observed:

app. time at ship.	obs. alt. ⊙'s l.l.
8^h 16^m 48^s A.M.	31° 38′ 55″ bearing East.
11 1 54 A.M	61 10 45

eye 22 feet: course and distance in the interval S.¼E. 8 miles, lat. by account 30° 1′N.: long. 117° 17′E.: required the true latitude when the second observation was made.

4. Verify No. 3 by Sumner's method.

5. April 15, 1861: lat. 16° 50′N.: long. 99° 55′W.: equal altitudes of ⊙ being observed, when the corresponding times by chronometer were 15^d 3^h 50^m 40^s and 15^d 9^h 20^m 40^s determine the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. Feb. 19, 1861: P.M. at ship: lat. 31° 7′S.: time by chronometer 18^d 20^h 5^m which was supposed to be 59^s fast on M.T. at Greenwich:

	obs. alt ⊙'s l.l.	obs. alt. ☾'s u.l.	obs. dist. ⊙ & ☾ n.ls.
	42° 20′ 10″	30° 20′ 10″	105° 16′ 20″
index error	0	+ 43	— 2 3

eye 20 feet: required the longitude and error of the chronometer on mean time at Greenwich by lunar observation.

7. April 27, 1861: the observed altitude of the ⊙ in an artificial horizon being 61° 15′ 40″: index error —2′ 10″: required the true altitude of the sun's centre.

8. A ship by dead reckoning has made S.44°E. 97 miles, but by observation she is found to have made S.11°W. 101 miles: determine the set and drift of the current.

Paper III.

1. June 9, 1861 : long. 31° 30′E. : observed meridian altitude ☾ 39° 14′ 40″ : zenith S. of ☾ ; index error +2′ 15″ : eye 24 feet : required the latitude.

2. May 15, 1861 : at $11^h\ 0^m\ 50^s$ P.M. mean time at ship : long. 30° 40′W. : the observed altitude of Polaris off the meridian being 49° 58′ 40″ : index error —50″ : eye 22 feet : required the latitude.

3. May 28, 1861 : the following observations were made for latitude by double altitudes.

app. time at ship,	obs. alt. ☉'s l.l.
$28^d\ 0^h\ 58^m\ 33^s$	66° 31′ 50″ bearing N.W. by N.
28 3 29 42	35 43 10

eye 18 feet: the course and distance in the interval S.W.byS. 14 miles: lat. by ac. 3° 33′N. : long. 75° 25′W.: required the true latitude when the second observation was taken.

4. Verify No. 3 by Sumner's method.

5. May 16, 1861 : lat. 20° 28′S. : long. 28° 51′W.: equal altitudes of the ☉ being observed, when the corresponding times by chronometer were $15^d\ 23^h\ 5^m\ 30^s$ and $16^d\ 4^h\ 52^m\ 10^s$: required the error of the chronometer on apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. June 24, 1861 : P.M. at ship : lat. 36° 9′S. : time by chronometer $24^d\ 0^h\ 53^m$, which was supposed to be 33^s slow on mean time at Greenwich :

	obs. alt. ☾'s l.l.	obs. dist. Fomalhaut & ☾'s f.l.
	28° 57′ 10″	40° 38′ 50″
index error	— 28	

eye 21 feet : required the longitude and error of chronometer on mean time at Greenwich, by lunar observation.

7. May 24, 1861 : the observed meridian altitude of the sun's lower limb in an artificial horizon being 97° 43′ 50″ : index error +1′ 20″ : required the true altitude of the sun's centre.

8. A ship by dead reckoning makes N.byE. 106 miles, by observation she is found to have made N.N.W. 100 miles : determine the set and drift of the current.

Paper IV.

1. July 20, 1861: long. 30° 45′W.; observed meridian altitude ☾ 58° 0′ 20″: observer S. of ☾: eye 22 feet: required the latitude.

2. July 10, 1861: at $11^h\ 54^m\ 40^s$ P.M. mean time at ship: long. 171° 50′E.: the observed altitude of Polaris off the meridian being 61° 0′ 30″: index error —1′ 39″: eye 27 feet: required the latitude.

3. July 3, 1861: the following double altitude of the sun was taken:—

app. time at ship.	obs. alt. ☉'s l.l.
$7^h\ 44^m\ 27^s$ A.M.	27° 41′ 52″ bearing E.by N.¾N.
0 45 1 P.M.	73 0 40

eye 18 feet: course and distance in the interval E.byN.¾N. 12 miles: lat. by account 10° 12′N.: long. 122° 36′E.: required the latitude when the second observation was made.

4. Verify No. 3 by Sumner's method.

5. August 5, 1861: lat. 37° 3′N.: long. 15° 16′E.: equal altitudes of ☉ being observed, when the corresponding times by chronometer were $4^d\ 19^h\ 40^m\ 20^s$ and $5^d\ 1^h\ 30^m\ 40^s$: determine the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. August 10, 1861: at about $7^h\ 2^m\ 10^s$ P.M. mean time at ship: lat. 4° 16′S.: long. by ac. 161° 47′E.:

	obs. alt. (Altair) *α* Aquilæ	obs. dist ✱ and ☾ f.l.
	20° 0′ 50″	112° 31′ 0″
index error	— 1 0	+ 1 40

eye 18 feet: required the mean time at Greenwich, and the longitude by lunar.

7. July 20, 1861: the observed altitude of ☉ in the artificial horizon being 98° 40′ 30″: index error —1′ 45″: required the true altitude of the sun's centre.

8. A ship by dead reckoning has made S. 7°W. 100 miles, but by observation it is found to have made S. 50°E. 94 miles: required the set and drift of the current.

Paper V.

1. Sept. 12, 1861: long. 170°E.: observed meridian altitude ☾ 50° 0′ 20″: moon N. of observer: index error +1′ 21″ eye 20 feet: required the latitude.

2. Sept. 10, 1861: at $2^h 30^m 15^s$ A.M. mean time at ship: long. 30° 17′W.: the observed altitude of Polaris off the meridian, being 54° 0′ 30″: eye 18 feet: required the latitude.

3. Oct. 29, 1861: the following observations were made for latitude by double altitudes,—

app. time at ship.	obs. alt ☉'s l.l	
$29^d\ 1^h\ 13^m\ 8^s$	58° 34′ 30″—1′ 4″	bearing N. W. by N.
29 3 38 20	35 23 28	

eye 12 feet: course and distance in the interval S.E.byS. 13 miles: lat. by ac. 40° 40′ 30″S.: long. 73° 56′W.: required the true latitude when the second observation was taken.

4. Verify No. 3 by Sumner's method.

5. Oct. 4, 1861: lat. 34° 19′S.: long. 115° 6′E.: equal altitudes of the ☉ being observed, when the corresponding times by chronometer were $3^d\ 19^h\ 0^m\ 50^s$ and $3^d\ 23^h\ 50^m\ 50^s$: required the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. Sept. 10, 1861: P.M. at ship: lat. 47° 58′N.: time by chronometer $1^d\ 5^h\ 18^m$:

	obs. alt ☉'s l.l.	obs. dist. ☉ & ☾ n.l's
	20° 1′ 10″	78° 56′ 50″
index error +	47	

eye 20 feet: required the longitude by lunar observation, and error of chronometer on mean time at Greenwich.

7. Oct. 10, 1861: the observed altitude of the ☉ in the artificial horizon being 65° 10′ 40″: index error +2′ 4″: required the true altitude of the sun's centre.

8. A ship by dead reckoning makes E. 158 miles, but by observation, N. 48°E. 130 miles: required the set and drift of the current.

Paper VI.

1. Dec. 11, 1861: long. 52° 9′E.: observed meridian altitude ☾ 75° 40′ 10″: zenith S. of ☾: eye 20 feet: required the latitude.

2, Dec. 15, 1861: long. 30° 15′W.: at 9^h 10^m P.M. mean time at ship: the observed altitude of Polaris off the meridian being 56° 20′ 30″: index error —1′ 2″: eye 19 feet: required the latitude.

3. Dec. 12, 1861: lat. by account 52° 26′S.: long. 106° 37′E.: the following double altitude of the sun was observed:—

app. time at ship.	obs. alt. ☉'s l.l.
1^h 17^m 30^s P.M.	56° 47′ 3″ bearing N.W.¾N.
4 30 30 P.M.	31 26 41

eye 19 feet: course and distance in the interval N.byE.½E. 28 miles: required the latitude when the second observation was taken.

4. Verify No. 3 by Sumner's method.

5. Dec. 9, 1861: lat. 48° 52′N.: long. 144° 46′E.: equal altitudes of ☉ being observed when the corresponding times by chronometer were 8^d 20^h 12^m 42^s and 8^d 22^h 30^m 46^s: required the error of the chronometer for apparent and mean time at the place of observation, and also on mean time at Greenwich.

6. Dec. 15, 1861: P.M. at ship: lat. 39° 10′N.: time by chronometer 5^d 13^h 15^m 4^s, which was supposed to be 44^s fast on mean time at Greenwich,

	obs. alt. ♃'s centre,	obs. alt. ☾'s l.l.	obs. dist. ♃ cent. and ☾ f.l.
	39° 53′ 20″	27° 58′ 0″	107° 18′ 0″
index error	+ 1 7	— 1 21	— 1 12

eye 20 feet: required the longitude by lunar, and the error of chronometer on mean time Greenwich.

7. Nov. 17, 1861: the observed meridian altitude of the ☉ in an artificial horizon being 79° 46′ 30″: index error —1′ 16″: required the true altitude of the sun's centre.

8. A ship by dead reckoning has made N.W. 76 miles, but by observation it is found she has made S. 81°W. 61 miles: required the set and drift of the current.

GREAT CIRCLE SAILING.

1. If, on a Mercator's Chart, any two places, (not on the equator, nor on the same meridian) be selected, we see that the shortest distance between them is a straight line, and providing no land intervene, and the winds and currents are favourable for the purpose, the navigator has no occasion to change the course on which he starts, in order to sail from the one to the other.

2. On a terrestrial globe, apply a piece of thread (stretching it evenly) to the same two places, and it will then be seen, that the shortest distance between them is *not* on a straight line, but on a portion of a circle, and in order to arrive at either place from the other, by such a route, the course to be sailed must be *constantly varying*.

(a.) When both places are on the equator or on the same meridian, the track on the great circle and that on the rhumb line are the same, and the course will be N., S., E., or W., according to the relative position of the ports.

3. Now the Earth is an oblate spheroid, or sphere of revolution, and the small difference between the equatorial and polar diameters does not preclude our regarding it as a perfect sphere in numerous computations.

4. If a sphere be cut in any direction by a plane, the section must be a circle.

(a.) If the plane pass through the centre of the sphere, we have a *Great Circle*, and the sphere is divided into two equal parts: the equator and meridians are examples.

(b.) If the plane does not pass through the centre of the sphere, the section is a *Small Circle*, dividing the sphere unequally: take the parallels of latitude as examples.

5. Two great circles always intersect in two points at the distance of a semicircle from each other.

(a.) The equator, which is a great circle, bisects every other great circle on the earth's surface, and there must necessarily be two points in every such circle, equi-distant from the equator, and at the same time furthest removed from it: each of these points is called "Vertex;" and the "Latitude of Vertex," which is the highest latitude attained in sailing on a Great Circle, is the nearest approach to the elevated pole. The meridian cutting the great circle at right angles, and dividing it into quadrants, is called the "Meridian of Vertex;" and the "Longitude from Vertex," is the arc of the equator intercepted between the meridian of any place and the meridian of Vertex.

6. The arc of a great circle joining two points, is the shortest distance between them on the surface of a sphere.

(a.) The same great circle cannot be drawn through more than two points, selected at random on the surface of a sphere.

7. A spherical triangle is the portion of space on the surface of a sphere, included between three arcs of intersecting great circles. All the computations for Great Circle Sailing are performed by Spherical Trigonometry.

8. The configuration of the earth is truly represented on Mercator's Chart only at the equator, every where else it is distorted: the great circle track between any two places, drawn on such a chart, instead of appearing (as it really is,) the shortest, would be represented as a curved line. It is impossible, under any circumstances, to sail a ship on the true great circle track, but a very close approximation may be made to it in some latitudes; and moreover a knowledge of Great Circle Sailing is very useful in all latitudes, for when adverse

winds are encountered, it teaches on which tack to lay the ship, in order to arrive most speedily at her destination.

These few observations will suffice, since it is not required to enter into calculations, and it is necessary to be provided with Towson's "Tables to facilitate the Practice of Great Circle Sailing," at the end of which will be found explanations as to their use, as well as the linear index which accompanies them.

GREAT CIRCLE TRACKS AND DISTANCES, AND AZIMUTHS WITHOUT CALCULATION.

Mr. Russel has supplied Diagrams of Great Circle Sailing, (published by Mrs. Taylor, of the Nautical Academy, in the Minories,) by which the science becomes little more than a mechanical operation, and which relieves it of all the difficulty of abstruse calculation. On Mr. Russel's sheet, there is with a Spherical Diagram, a Mercator's Chart,—to facilitate the finding of the Great Circle, and the distance between any two given places.

The principles on which the Diagram is constructed may be easily understood; for, as every Great Circle cuts the Equator in two points diametrically opposite, it follows that a series of great circles drawn through a given point in the Equator, in every possible direction, will all meet at another point in it, 180° distant from the former. Any person accustomed to navigate his ship by Great Circle Sailing, will readily understand the nature and advantages of Mr. Russel's plan and we recommend it to the attention of commanders of vessels, who are bound on distant voyages.

Vide *Shipping Gazette*, March 19, 1853.

LAW OF STORMS.

BY WILLIAM RADCLIFF BIRT.

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THE object of the following remarks on Revolving Storms, is to exhibit the importance of gaining such a knowledge of the "Law of Storms," that the commander of a vessel may know instinctively what part of a cyclone he may be in; for this, nothing more is requisite, than that he possess a competent knowledge of the bearing of the centre from the ship, as determined by the direction of the wind, and the result of the hauling of the wind with or against the sun, as indicating on which side of the axis line he may be placed, the axis line coinciding with the *path of the centre;* with this knowledge all instruments may be dispensed with, except the barometer.

1. Within the last 30 years the assiduity of meteorologists has developed a most important and highly interesting department of meteorology. This department has immediate reference to, and must exert a most beneficial influence on the Commercial and Maritime interests of the Country. It is now popularly known as the Law of Storms, and on no class of men can the study of it tell with more effect, than on the mercantile marine; not that Her Majesty's Navy stands less in need of the important knowledge contributed by an investigation of storms, but the education of its officers fits them more readily to appreciate and apply such knowledge, when overtaken by a hurricane or cyclone.

2. The primary idea or fundamental notion of a cyclone, is that of a vast body of air in a state of rotation, more or less

rapid. This rotation appears to be immediately connected with the rotation of the earth, or rather with the apparent course of the sun in the heavens, arising from the earth's rotation on its axis. The rotation of the air around the axis of the cyclone producing the hurricane wind, is *always* contrary to, or against the apparent course of the sun, and as the apparent course of the sun is reversed in the opposite hemispheres, so the rotation of the air in the cyclone is in opposite directions on either side of the equator. A very simple rule is deducible from these beautiful facts. In the northern hemisphere the cyclone rotates in a direction contrary to that in which the hands of a clock move, but in the southern hemisphere the rotation coincides with the movement of the hands.

3. This whirling of the air in a cyclone, enables us to characterize certain portions of the storm by certain hurricane winds; thus, in the northern hemisphere the *northern* margin of the storm always exhibits an *easterly* wind, the *eastern* margin a *southerly* wind, the *southern* margin a *westerly* wind, and the *western* margin a *northerly* wind: we shall also further find upon dividing the storm into quadrants, by diameters drawn from the northern to the southern, and from the eastern to the western margins, that upon the *northern* semidiameter, or radius, the wind will be *east;* on the *eastern, south;* on the *southern, west;* and on the *western, north;* each portion of the cyclone will possess its appropriate wind. (Fig. 9, p. 115.)

4. The relation of the winds to the margins and semi-diameters in the southern hemisphere, will be exactly the reverse of their relations in the northern; thus it is the *southern* semi-diameter and margin of a storm, south of the equator, that exhibits an *easterly* wind, the *western* a *southerly,* the *northern* a *westerly,* and the *eastern* a *northerly.* (Fig. 10, p. 115.)

5. This arrangement of the winds in a hurricane, will

conduct us to a very simple rule for determining the position of a vessel in a cyclone, and as a consequence the bearing of the centre of the storm from the ship. From the *easterly* wind in the northern hemisphere, the centre will bear *south,* or *eight* points, *reckoned in the same direction as the apparent course of the sun,* an *easterly* wind characterizing the *northern* margin: from a *northerly* wind the centre will bear *east*; from a *westerly* wind it will bear *north*; and from a *southerly* wind *west*; thus the direction of the wind *only* in a revolving storm, will announce to the commander of the vessel, two very important points,—his exact position in the cyclone, and the bearing of its centre from his ship.

6. The same simple and very perspicuous rule holds good in the southern hemisphere. From an *easterly* wind, the centre of the storm bears *north* or *eight* points, *reckoned in the same direction as the apparent course of the sun,* the sun rising in the east, culminating in the north, and setting in the west. From a *southerly* wind the centre bears *east*; from a *westerly, south*; and from a *northerly, west.* These bearings are precisely the *reverse* of those in the northern hemisphere, but as the apparent motion of the sun is also *reversed,* the rule is applicable to both hemispheres. THAT THE CENTRE OF A REVOLVING STORM BEARS *EIGHT* POINTS FROM THE DIRECTION OF THE WIND AT THE SHIP, RECKONED WITH THE APPARENT COURSE OF THE SUN.

7. While the atmosphere *within* the cyclone is in so rapid a state of rotation, that the moving air frequently attains a velocity of about one hundred miles an hour, the exterior zone is strikingly characterized by certain meteorological appearances, which herald, as it were, the approach of the coming storm. The rapid motion of the air within the whirl, combined with the *sucking in* of the exterior air com-

paratively at rest, produces an immense condensation of vapour generally seen on the horizon in the direction of the cyclone, as a dense, dark, lofty wall or bank of cloud. As the vessel approaches the storm, this bank of cloud appears to advance, and draw down closely upon the ship, so that she becomes involved, and then the clouds present so appalling an aspect, they appear to be so close to the vessel, and so solid in their structure, that a commander may almost fancy he can from the vessel, put his hand on them.

8. When the ship approaches so near the cyclone, as to experience the effect of the outward gyration, the weather becomes still more significant, the proper wind of the hurricane generally characterized as strong and squally, carries over the vessel portions of the great bank of cloud peculiar to the storm, these portions are torn into rags and shreds, while the bank still marks the locality of the cyclone. From this point a run of two hours *toward* the centre will generally involve a ship in an impetuous and terrific hurricane.

9. There are also other appearances of the weather that are exceedingly significant of the approach and presence of a cyclone. Very frequently, a short time before one of these visitants bursts on the ship, the sky presents a lurid threatening aspect, the state of the atmosphere being oppressively sultry, the clouds vary in their colour from a deep and angry red to a peculiar heavy olive; in such cases the cyclones have been very destructive. More rarely, every object has been seen tinged with a deep crimson, and it has been ascertained, that on such occasions the ships have not been far from the destructive gyrations. Sometimes the sun, moon, and stars shine *differently*, they may be seen, for example, with remarkable distinctness previous to a revolving gale, and they not unfrequently shine as pale sickly luminaries, having around

them large circles of light known as halos; on such occasions the stars "look big with burrs about them." The sun, on the approach of a cyclone, has been observed "pale even as the full moon," and in a few rare instances, not only has he been seen as a *blue* sun, but his rays have tinged all surrounding objects blue. The wind has been heard fitfully moaning and roaring violently, as the ship has neared the destructive hurricane; and on shore, branches of trees and other small bodies have been seen to whirl about in a most peculiar manner. Ships that have passed through the centres of cyclones have mostly recorded a clear sky accompanied by a calm; this clear sky is known as the storm's eye.

10. The feature next in importance to the rotation of a cyclone, is its progressive motion, and this in all ordinary cases is reducible to the same order and regularity as we have seen characterizing the rotation; commencing at a point a few degrees north of the line, the cyclone moves bodily forward towards the west, its course is however, soon directed a little north of west, and as it approaches towards 20°N. lat. its course is more or less towards N.W., at 30°N. lat. its course for a short time is due north, here it *recurves*, and afterwards is directed towards the N.E. This course is peculiar to the western portion of the basin of the Northern Atlantic. The usual storm paths in this locality, may be divided into ordinary and extraordinary. The ordinary conforming to the course above mentioned, and the extraordinary departing from this type.

11. Upon combining the rotatory with the progressive motion, some very valuable rules for the guidance of commanders may be deduced. The path which the axis of gyration describes, is not inappropriately termed the *axis line*, and this divides the cyclone into two *semi-circles*, the right or *star-*

board semi-circle, and the left or *port* semi-circle; we have consequently three divisions of a storm, each characterized by different phenomena. In the right hand semi-circle, the hauling of the wind resulting from the passage of a cyclone in the northern hemisphere, is in the same direction as the apparent course of the sun, but in the left hand semi-circle, it is reversed, being opposite to or against the sun. On the axis line there is no change of wind until the centre has passed, when after a short lull or calm, the wind springs up with great fury from the opposite quarter.

12. The rules deduced from the progressive motion of a storm, combined with its rotation, are probably best enunciated as well as elucidated by a series of examples, of which the first has reference to the western portion of the basin of the Atlantic, where the ordinary storm paths follow more or less the course of the Gulf stream.

(a.) A vessel pursuing the usual course to the West Indies, shortly after passing 50° W. long. observes unmistakeable meteorological signs of a hurricane bearing down upon her, *i.e.* the dense bank of cloud, &c. is seen astern, not ahead; when she becomes involved in the scud, and the jagged and torn clouds skirting the cyclone are flying swiftly past her, the steady N.E. trade is replaced, not by a wind from a different quarter, but by a wind still from the N.E. of greater intensity, and characterized by strong and sudden squalls; she is now upon the N.W. margin, or rather just within the N.W. verge, the centre bears S.E. of her, and if she scud before the wind, she will approach the axis line of the storm. If however, she should heave-to on the *starboard* tack, and allow the cyclone to pass over her, the wind will haul by E.N.E.-E.-E.S.E.-S.E. and S.S.E.

this will be in accordance with the apparent course of the sun, and an extensive generalization indicates that in the northern hemisphere the wind always HAULS WITH THE SUN IN THE RIGHT HAND, OR STARBOARD SEMICIRCLE OF A ROTARY STORM.

(b.) A vessel pursuing the same course, when overtaken by a cyclone, and observing the significant meteorological signs, experiences a slight change of the N.E. trade; the wind changes to N.N.E., and rapidly increases in force, until at last, with a very furious wind from the same quarter, N.N.E., it becomes suddenly calm; after this calm has continued about half an hour or more, the wind as suddenly springs up from the opposite quarter, or S.S.W.; while this wind continues, its force abates until the storm has passed, and the N.E. trade again resumes its sway. In this instance, at the commencement of the storm, the centre of the cyclone bears E.S.E. of the ship, and afterwards passes over it, so that the general rule may be deduced, that ON THE AXIS LINE, A VESSEL EXPERIENCES ONLY TWO WINDS, ONE THE OPPOSITE OF THE OTHER, WITH AN INTERVENING CALM BETWEEN.

(c.) A third vessel experiences a still greater change of wind; the N.E. trade instead of being replaced as in the first instance, by a violent wind from the same quarter, (the N.E.) is succeeded by a northerly wind. If this vessel lie-to on the starboard tack, the winds she will experience will be as follows, N.W., W. and S.W. The hauling in this case is exactly in the opposite direction to that in the first instance, it is contrary to, or against the apparent course of the sun; THE HAULING OF THE WIND THEREFORE, IN THE LEFT HAND OR PORT SEMI-

CIRCLE OF A REVOLVING STORM IN THE NORTHERN HEMISPHERE, WILL ALWAYS BE AGAINST THE SUN.

These rules will be found very valuable. The direction of the wind at the ship will give her position in the storm as referred to the points of the compass, and what is of immense importance, the bearing of the centre from her; the hauling of the wind will announce her position relative to the axis line, and combined with her track through the cyclone, will give the direction in which the storm itself is moving; if the wind be found to increase in force *without hauling*, the ship is on the axis line, and if a calm occur, succeeded by a terrific and violent wind from the *opposite quarter*, the ship has passed through the centre.

13. Most of the West Indian vessels and those navigating portions of the Atlantic Ocean off the Mexican Archipelago, will generally experience the winds of the starboard semi-circles of cyclones in which they may happen to be involved. It will only be, as a general principle, when they are within the Caribbean Sea, the Gulf of Mexico, or the Channels between the Islands, that they will experience the winds of the port semi-circle. In the latter instances, there are no means of avoiding the fury of the storm by standing towards the margin, except it should sweep over the more open parts of the Caribbean Sea, and Gulf of Mexico. Vessels in the Atlantic may readily avoid the violence of the winds of the starboard semi-circle, by standing to the north and north-east, and by being so trimmed that they may receive the cyclone wind on the starboard side of the ship.

14. We are here introduced to a rule of very considerable importance in manœuvring a vessel, when overtaken by a storm of a revolving character. In the northern hemisphere,

if a ship receive the wind on her *port* side, her head is directed more or less *towards* the centre of the cyclone; but if she receive it on her *starboard* side, her head is turned *away* from the centre. These facts readily indicate the means to be adopted, either to retire to, or beyond the margin of the storm, or to draw from the centre when lying-to. If with the ship's head from the centre, she receive the wind on the starboard side, then in lying-to or drawing from the centre, she must be trimmed on the *starboard tack.**

15. In the example (a) a West Indian vessel taking the storm at N.E. it is stated "that if she scud before the wind, she will approach the axis line of the cyclone," she will in fact be rapidly approaching *the centre,* which in consequence of its curved path, is likely under these circumstances, soon to overtake her. In no other part of the storm does a vessel so rapidly near the centre by scudding as in this, and the *octant of the starboard semi-circle in advance of the centre and abutting on the axis line,* is consequently regarded as by far the *most dangerous* portion. When the gale sweeps along the islands separating the Caribbean Sea and Gulf of Mexieo from the Atlantic, the most dangerous octant is characterized by north-easterly and easterly winds.

16. Mr. Piddington in one of his admirable works on Indian Storms, has this pertinent remark on the utility of the barometer, "He who watches his barometer, watches his ship." The barometer is an invaluable instrument in a cyclone, it announces to the commander his approach to the vicinity of a revolving storm, it advertises him of his plunging into its

* The reverse of this takes place in the Southern Hemisphere, a vessel sailing *out of* the gale, receives the wind on her *port* side, she must therefore be trimmed on the *port tack.*

vortex, it acquaints him with his recess from the centre, and by carefully noticing its indications, he may, to a great extent, avoid the disastrous consequences of a hurricane: for the laws of its oscillations in a cyclone, are very distinctly marked.

17. A short time before the significant meteorological appearances noticed in sections 7, 8 and 9 are observed, the atmosphere is generally, especially in certain latitudes, very calm, the air is oppressively sultry, and the barometer usually stands very high. Observations appear to indicate that this is mostly, if not always the case, *around* the storm, so that it is surrounded by a margin characterized by a *high barometer*, and a hot, sultry atmosphere. In the direction of the cyclone the clouds assume the appearance of a dark, livid bank, in most cases presenting an appalling and threatening aspect. If a diameter of the cyclone be drawn transverse to the axis line, dividing the starboard and port semi-circles into two equal quadrants, it will exhibit those portions of the storms, in which the barometer will fall and rise. While the first half of a storm passes a ship, the barometer will fall, and while the succeeding half passes it, the barometer will rise. The transverse diameter will also be characterized by a barometer which is proportionally lower, as the centre of the cyclone is approached. In most cases of manœuvring, it is desirable to keep just within the verge of the storm; and here, the barometer is of signal benefit, as, by keeping it as high as possible without losing the cyclone winds, the vessel is kept just within the margin. In whatever position the ship may be, the rising of the mercury announces that the first half has passed.

18. Vessels navigating the Atlantic, off the Bahamas, and Florida, will experience important differences in the phenomena, according as they pass through the starboad, or port

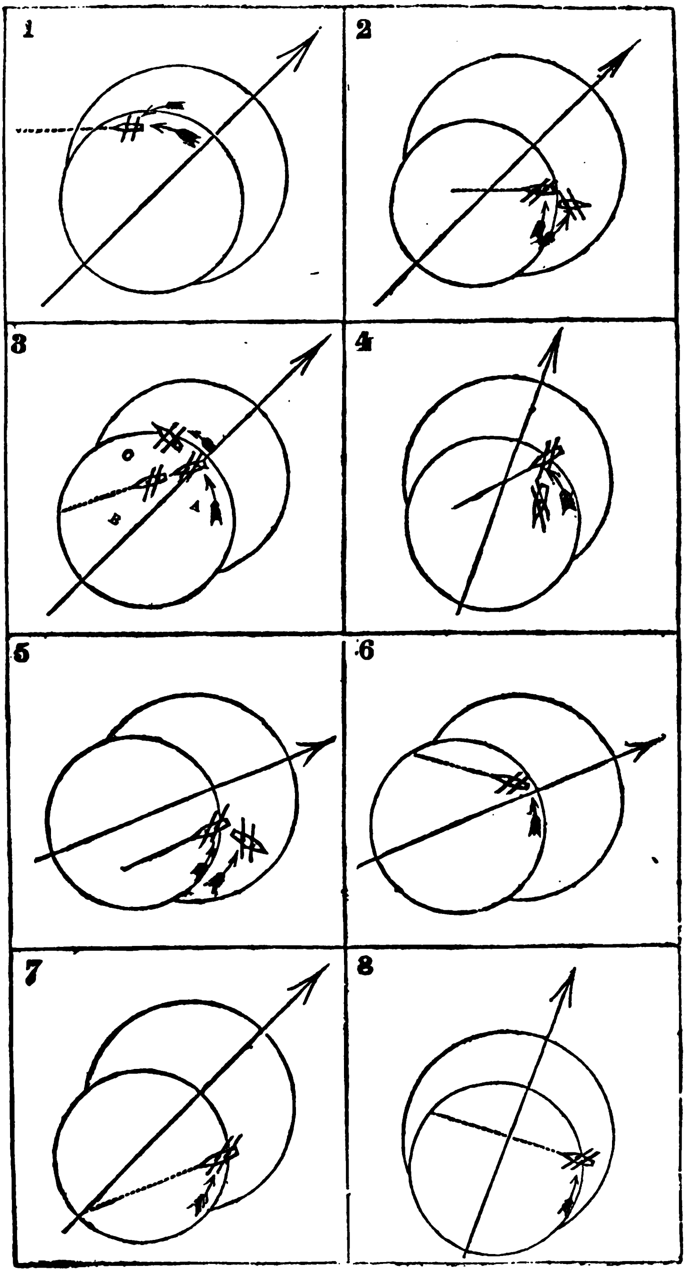
semi-circles of a cyclone. Sweeping along the West Indian Archipelago, the path of the cylone has been, more or less, towards the north-west: a vessel with a north-westerly course receives the northern margin of the gale with the wind from east, and if she pursue her course, the cyclone gaining on her, she soon experiences a favourable wind for her voyage, the barometer falls until she is fairly under the influence of the S.E. wind, and by sailing parallel with the centre, she has a fair wind for the rest of her voyage, *providing the cyclone does not alter its direction: the fresh breeze from the S.E. with a steady barometer, indicates that she preserves her parallelism with the centre.* If, however, the barometer fall, and bad weather be rapidly experienced, the course of the ship no longer continues parallel with that of the gale; the centre is rapidly nearing her, and if means were not adopted to keep the vessel near the margin, it would, under the circumstances here supposed, be so involved, that the centre would shortly overtake her. In the locality mentioned, a S.E. wind will invariably conduct the vessel to the centre, but if she lie-to as soon as she finds the barometer falling, she will avoid getting nearer the centre, the wind will continue to haul with the sun, and the gale will finally leave her between S.W. and W. The most advantageous manœuvre in these localities, would be to lie-to, as soon as unmistakeable indications of the cyclone *recurving* were perceived; "to wait on it," (to use the expressive phrase of an East Indian Captain,) until the passage of the S.E. wind succeeded by a southerly gale and rising barometer, gave notice that the first half of the gale had passed, and then to cross the receding portion as far from the centre as may be consistent with safety, in order to pursue the original course of the vessel.

19. From the above remarks it is evident, that if a vessel navigating these seas, take the cyclone with any wind in

the port semi-circle, the recurving will so operate that the vessel will soon be removed from its influence, but a vessel in the starboard semi-circle requires more than ordinary care in manœuvring, to avoid the centre bearing down upon her.

20. Vessels bound from England to America, as they approach the coasts of the United States, will usually experience the starboard winds of a cyclone: these winds will differ, to some extent, from those characterizing the starboard semicircle of the West Indian hurricanes, inasmuch, as the general direction of the storm path is, in the case before us, towards the N.E., see Figs. 1, 2, and 7. Upon the track, south of the Gulf Stream, the vessel may take the hurricane by sailing into it at two points; she may either sail into the posterior quadrant, getting a westerly wind, which upon her waiting, will soon leave her, or the hurricane may meet her in the most dangerous octant with the wind at south: in this case, upon her lying-to, the wind hauling with the sun, she will experience the following winds, S.,-S.S.W.,-S.W.,-W.S.W., and W.: as in this case, and also in those of the two northern passages, a vessel upon being involved, will have the hurricane interposed between it and the land, the most prudent step appears to be, "to wait on the cyclone," until the S.W. wind has passed, and the barometer begins to rise, when the earliest opportunity may be embraced for crossing its wake. She should be hove-to on the *starboard* tack, and if while waiting she finds her bad weather to increase, she should stand a little to the eastward to avoid it, as shewn in Fig. 2.

21. Not only may a ship sail into a hurricane as she pursues her track to America, she may be so situated as to meet with *easterly* winds hauling against the sun; in this case, with the cyclone travelling N.E. she need not trouble herself about the storm, her wind is fair, and she can lie her course without inconvenience, see Fig. 1.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22. The hurricane season generally sets in, in the Northern Atlantic, as the sun is leaving the tropic of Cancer, shortly after the summer solstice, and continues until he has passed to some distance south of the equator; the cyclone months are consequently, July, August, September, and October, also November and December.

23. During the month of July hurricanes are rare in the part of the Atlantic navigated by vessels bound to the United States, but in the months of August and September the tracks of most ships lie in the district where the paths of the centres of cyclones are most numerous. If a vessel be sailing on a W.S.W. course as shewn in fig. 3, and the cyclone so overtake her, that she experiences an *easterly* wind, hauling against the sun or to the N.E. she may pursue her course, unless the wind becomes inconveniently strong, or there are unequivocal indications of the hurricane moving more northerly than usual, in either of these cases a standing to the *west* will generally relieve the vessel.

24. Vessels on a W.S.W. course in this part of the Atlantic are much more likely to fall in with S.E. than with E. winds, and in such cases they will find it convenient to stand W. or even N.W. "carrying on" is likely to bring the ship *too near* the axis line, even if the hurricane be moving E.N.E. This is shewn in Fig. 3, in which A represents the ship taking the S.E. wind, B the same ship standing on her course, and C one breaking off to the N.W.

25. If a cyclone be moving N.N.E. and a ship upon a W.S.W. course meets it on the N.E. quadrant, with the wind from S.E. it is exceedingly probable she will by "carrying on" sail immediately upon the centre, the path of the hurricane being so inclined to the ship's course, as to occasion the meeting of the ship and centre in the shortest time possible; in such a case, if the ship sails close hauled, heading S.S.W. in the first

instance, *i.e.* immediately on becoming aware of the proximity of the hurricane, and then waiting (if hove-to it should be on the starboard tack) until she gets the wind hauling to the *west* of *south*, she may afterwards pursue a course parallel to her original one behind the centre of the storm, see fig. 4.

26. If a ship on a W.S.W. course meet a S.E. wind, and the commander find it rapidly veering to E. with bad weather and a falling barometer, it is not only an indication that the cyclone is moving towards the N.E. but that the vessel is most assuredly approaching the centre. A W.S.W. course with a S.E. hurricane wind between 50° and 65°W. long. and 37° and 42°N. lat. is fraught with danger. The best course a commander can adopt under such circumstances is undoubtedly to edge away to the N.W. upon the earliest indications of bad weather, keeping his eye steadily on the barometer, (see sections 16 and 17,) which if the cyclone be advancing towards the N.E. will assuredly *rise;* but should the course of the storm be more northerly it will *fall;* in this case he should edge away still more to the north to keep up his barometer, until he has *crossed* the axis line, unless he has reason to believe that he cannot cross it without imminent risk, in which case he may adopt the course recommended in section 25. For an illustration of the position and manœuvres recommended in this section, the reader may consult fig. 3, in which A represents a ship meeting a cyclone on the N.E. quadrant; B, the ship standing on and plunging towards the centre; and C, a vessel breaking off to N.W. to sail round the northern edge.

27. A ship upon a W.S.W. course falling in with southerly hurricane winds, within or near the limits mentioned in section 26, will, upon the wind veering, find herself "headed off," should the cyclone be moving towards E.N.E.; nothing

can be better in such a case than to adopt Col. Reid's rule, and put the ship on the starboard tack, her head E.S.E. away from the centre. While "standing on" in this direction, she will find the wind veering westwardly, and this will allow the course gradually to be changed, while the ship is creeping round the southern margin. Fig 5 illustrates this manœuvre, and it will be seen that this is the only safe course the commander can adopt, *unless he has time to turn his ship's head northward, and sail round the advancing front.*

28. I have elsewhere * solicited the attention of commanders particularly to the manœuvre of sailing round the advancing front of a storm, and I cannot do better than quote my remarks on that important point, they are to this effect. THAT VESSELS BOUND WESTWARDLY, WHEN MEETING WITH THE STARBOARD SIDE OF A REVOLVING STORM, SHOULD NOT "CARRY ON," BY WHICH THEY MAY SAIL OR STEAM INTO THE HEART OF THE HURRICANE, BUT SHOULD SAIL ROUND THE ADVANCING FRONT, SO AS TO MAKE GOOD NORTHING AND WESTING BY HELP OF THE S. AND S.E. WINDS, AND TAKE UP A GOOD POSITION IN THE LEFT HAND SEMICIRCLE WITH A FAIR WIND.

29. It is requisite in sailing round the advancing front, as directed in the above rule, to exercise great caution, and to edge away to the N.E. that the vessel be not caught on the axis line *too near* the centre to extricate her from danger. Not only is a close attention to the barometer essential, by keeping it well up &c. but the manœuvre should be executed upon the *earliest* symptoms of the southerly wind setting in, and the commander should not forget that he is here in the most dangerous quadrant, and by successfully crossing the storm's track, he gets a

* Hand Book of the Law of Storms, p. 98.

fair wind for his voyage; whereas if he "carry on" through the heart of the gale, what he gains one way he loses the other, by meeting with contrary winds, damage, &c. If however the gale should be very extensive, and there should be indications of the commander being *unable* to cross the axis line successfully, a point that requires the deepest consideration, the best and most prudent course is that recommended in section 27.

30. The commander of a ship on the same course (W.S.W.) meeting with a hurricane wind from the S. the cyclone travelling towards the N.E. will find that on her being brought to, on the *starboard* tack, the cyclone will get northing, and as the wind veers aft she can stand to the southward, to avoid the influence of the starboard winds which will "head her off," until her original or a parallel course can be resumed, see fig 7. If, however, the hurricane be travelling towards N.N.E. all that is necessary is to bring the ship to on the *port* tack, until she can lie her course; she cannot suffer materially if she fall in with a southerly wind, the cyclone travelling N.N.E. The general direction of the paths, within the limits above specified (section 26) is however E.N.E. and the commander should be perfectly satisfied, before heaving-to on the port tack, that the cyclone is moving towards N.N.E.

31. In paragraphs 23 to 30, directions have been given for manœuvring vessels upon a W.S.W. course, between 50° and 65°W. long. and 37° and 42°N. lat. In the same locality, however, many ships steer a W.N.W. course, and this requires altogether a different manœuvring on the part of commanders. It is considered that of all the courses a ship may pursue in the hurricane region, this (W.N.W.) is by far the most dangerous, it directly *crosses* the paths of the cyclones as they come up from the S.W. A ship on this course meeting with a S.S.E. wind, which is very likely, may "carry on," if the cyclone be moving

towards E.N.E. The ship and gale are every moment parting company, and she has fair wind, as shewn in fig. 6. If, however, the hurricane be moving towards N.E. or N.N.E. commanders are likely to find themselves in very trying circumstances; to "stand on," in either of these cases, the ship must be involved. To attempt to sail round the front, especially when the cyclone is moving N.N.E. would perhaps be attended with no little difficulty. Numerous circumstances must be taken into account, especially the four which constitute, in Mr. Piddington's estimation, the *great elements of the problem*, viz. *The ship and her sea room; the track of the cyclone; its rate of travelling; and the ship's run or drift. Every ship, therefore, in every cyclone must have its own peculiar management.* And what is that management in the case now under consideration? Most probably a heaving-to on the *starboard tack*. In fig. 8, the cyclone is represented as moving towards N.N.E. the ship's course is at right angles to that of the hurricane. She receives the S.S.E. wind on her port side, and as she lies her course she comes just athwart the centre. To bring her to on the *port* tack would *save* time, but the veering of the wind would most probably cause her to "fall off," until she laid in the trough of the sea, which would get the controul over her, and she would have no canvas to "wear." To heave to on the starboard tack is the proper course, in fact to manœuvre in precisely a similar manner to that recommended in section 27, and illustrated by fig 5.

32. The entire storm paths of the Western Atlantic, are characterized by certain winds, that are *most dangerous* to vessels falling in with the West Indian and North American cyclones. Off the West Indian Islands, the most dangerous cyclone winds are, N.E. and E.N.E. A short time before recurving, or rather about the period of recurving, vessels off the Bahamas and Florida, find E., E.S.E. and S.E. winds

most dangerous; after recurving, vessels off the coast of the United States, are placed in considerable jeopardy by S.S.E. and S. winds. The general sweep of dangerous winds in the Northern Atlantic, may be thus specified:—

N.E.,-E.N.E.,-E.,-E.S.E.,-S.E.,-S.S.E. and S.

33. The remaining localities in which storms are frequent, in the northern hemisphere, are the Bay of Bengal, and the China Seas. In the Bay of Bengal, the progressive motion is towards the N.W. or, more properly speaking, from E.S.E. to W.N.W. The same rules apply to these hurricanes, as to those of the Northern Atlantic, the hauling of the wind on each side of the axis line, being similar to the hauling in a West Indian hurricane *before recurving;* consequently, the winds affecting the ship, are the same. In the China Seas, the progressive motion, hauling of the wind, &c., are almost identical with those in the Bay of Bengal, and in both localities, no recurving analagous to that in the Atlantic is observed. The hurricanes in the Bay, and the typhoons in the China Seas, appear to lose themselves in, or are dispersed by, the more elevated continental tracts, over which they pass, before they can reach the locality of recurving in the northern hemisphere.

34. We have already alluded to the fact, that the rotation of a cyclone in the southern hemisphere, is exactly opposite to the rotation of one in the northern, (sec. 2.) both being opposed to the apparent course of the sun. The hurricane region, south of the equator, extends more or less, over the entire area of the S.E. trades in the Indian Ocean; the season in which they occur, being characterized, as in the northern hemisphere, by the sun leaving the tropic, and approaching the equator; this is from December to April, as the sun leaves the tropic of Capricorn. Hurricanes are very seldom

met with in November or May, and in the remaining five months of the year, so far as our present knowledge extends, they are unknown.*

35. The progressive course of the southern cyclones is in accordance with similar laws characterizing that of the northern; commencing a few degrees south of the equator, they move first towards the west, very slightly inclined to south; as they approach 20° S. lat., the direction of their progress becomes S.W., and just before reaching 30° S. lat., they recurve, after which they move towards the S.E., and there is great reason to believe, that not very long after the point of recurving, their progressive motion is nearly due east.

36. There appears to be a very remarkable, and most interesting difference, in the latitudes of recurving in the southern hemisphere, as compared with the northern; while the latitude of 30°, may be regarded as the *mean* locality of recurving, so far as distance from the equator is concerned, the cyclones of the Indian Ocean are liable to recurve on any meridian, between the Cape and the western coast of Australia, and it would appear from observations, that they recurve in *lower* latitudes on the more *eastern* meridians. In this way taking the apices of the cyclone paths more and more west, a curved line may be traced from about 85° E. long. to the Cape, on which the latitude of recurving varies from about 12° to 35° south. This line of recurving is of very considerable importance, when it is considered that the great highway of the ocean, from India and China to the Cape, is nearly identical

* It is beginning to be ascertained that a well marked region of cyclones extends from the Cape to Australia, about the 40th parallel S.; also the East of Australia is a distinct cyclone region. See papers in the Mercantile Marine Magazine, for June and July, 1855.

with it, indeed, the two may be considered as pursuing the same track for about 20 degrees of longitude, viz. from 70° to 50° east, so that vessels coming from India and China, and sailing through this portion of the Indian Ocean, any time between December and April, are not only liable, on any day either to sail into a cyclone, or have one bearing down upon them, but their manœuvring may be proportionally complicated by the hurricane recurving, while they are within its influence.

37. The progressive motion of a southern cyclone combined with its rotation, will produce phenomena, as well marked as those which we have seen characterizing the northern storms. A vessel steering W.S.W. in the S.E. trades, observes all the significant meteorological signs of a hurricane (secs. 7, 8, and 9,) astern, and particularly to windward. The wind alters its character: instead of being a steady, fresh breeze, it becomes gusty and squally, the atmosphere is obscured, patches of cloud come away from the denser masses, of a loose, vapoury, ragged and torn character. These appearances, in such a locality are decisive, the ship is on the S.W. verge of a cyclone, and most probably on the axis line. In this instance, the winds of the S.E. verge are peculiarly favourable for the prosecution of the voyage, being north easterly. Two points are consequently matters for consideration, viz., to avoid the centre, and to get a favourable wind from the storm,—the liability of the cyclone to recurve, must not, however, be lost sight of, and the commander must keep a sharp and steady look out for the first indications of a change in the direction of its progress. To avoid the centre and get on the southern verge, the commander may stand to the southward, during which, the cyclone may gain westing, and pass the meridian of the ship, at which juncture the wind will be easterly; the course to the

south, provided the ship remains within the disc, may be continued until the wind becomes N.E., when the body of the storm is to the N.W. of her.

38. While these manœuvres are in progress, great care must be exercised, and a sharp look out kept for the *bend.* If upon standing to the S., when the earliest appearances of the neighbourhood of the cyclone are recognized, the weather does not improve, the hurricane is recurving, and a very slight westing will bring the vessel again into the steady trades, and fair weather; the ship in such a case, just grazes the verge of the storm. When the ship takes the cyclone at E.S.E., and the commander,—apprehending the motion of the storm to be W.S.W., waits until it gets westing, so that the verge may leave the ship with an E.N.E. wind,—finds that the easterly wind not only *hangs*, but bad weather is rapidly increasing; another indication is afforded of the cyclone recurving. In this case, loss of time may involve loss of ship. The westing of the vessel is now of the utmost importance, to remain hove-to when the significant signs of the centre bearing down from the north are unmistakeable, must expose the ship to all the fury of the gale, the best manœuvre appears to be, so to trim the vessel, that she may sail from the axis line toward the west, both ship and storm are then trending in opposite directions, which will the more quickly tend to extricate her.

39. Returning to the consideration of the case, (sec. 37,) in which the commander waited until he found himself on the S.E. verge, and a little further westing of the storm would leave the ship no longer exposed to its influence: it must be borne in mind, that although he might thus with ease, escape its fury, it would at some part of its course *recurve*, and very probably, he would again encounter it; if, however, before his leaving the cyclone, the wind should continue to veer, the

weather, instead of improving, should grow worse, and a northerly wind blow with increasing violence, then the commander could draw no other conclusion, but, that the hurricane had then arrived at the apex,—the western-most point of its path,—and was recurving; his object now would be, by waiting, to allow it to retain sufficient southing, so that he might cross its wake, without deviating from his usual course.

40. There are two or three points that require especial notice in these examples, the veering of the wind was S.E.-E.-N.E. *i.e.* with the apparent course of the sun; the semi-circle in which the ship manœuvred, was the port, or left-hand semi-circle, and the octant in which the ship took the gale, was the most dangerous. These facts furnish a general law, applicable to all storms in the Indian Ocean, viz. IN THE RIGHT HAND, OR STARBOARD SEMI-CIRCLE, THE WIND HAULS AGAINST THE SUN; AND IN THE PORT OR LEFT HAND SEMI-CIRCLE, WITH IT; the most dangerous octant is in the port semi-circle, in advance of the centre, abutting on the axis line, and in the great majority of cases, characterized by a S.E. wind, so that *before recurving*, a S.E. hurricane wind is the most dangerous.

41. A vessel, north of the axis line, has not near so much to contend with, as one south of it: if she take the gale on the N.W. margin, with the wind at S.W., by standing northward she may rapidly extricate herself, especially if the gale be about recurving; almost under any circumstances, by such a manœuvre, the centre of the storm and vessel are rapidly parting company.

42. The rotation of the wind in a storm violently agitates the surface of the ocean, producing a swell or *storm wave*, this wave is propagated in the same direction as the wind, characterizing the margin to which the swell is a tangent. The *undu-*

lations thus rolling from the margin, both in advance and regression of the storm itself, encounter each other and produce in the area of intersection, *cross seas* which are more or less dangerous, according as they are met with in advance or behind the hurricane. As the cyclone advances, a series of undulations are thrown off to the right and left, which flow in the direction of the two radii of the storm, dividing its semi-circles into quadrants. It is easy to see that these undulations *fringe* the storm's wake, they are found in fact to the right and left of the path which the storm has described.

43. In the left-hand or port semi-circle, in the northern hemisphere, and in the right-hand or starboard semi-circle, in the southern, a sea is given off which meets the undulations flowing to the right and left of the storm's path, and produces in the *left-hand side* of the storm's wake, in the *northern* hemisphere, and in the *right-hand side*, in the *southern* hemisphere, a tremendous pyramidal sea. When the cross turbulent sea is encountered, it is a pretty sure indication that the storm itself has passed the locality. A few examples in the southern hemisphere, will illustrate the effect of the cross seas, according as they are met with, in advance, or on the right or left hand of the storm's path.

44. A vessel in the Indian Ocean meets with a cyclone wind at S. heralded by the significant meteorological signs characterizing the approach of a hurricane, but has not experienced any remarkable disturbance of the nature of a cross sea. This is a very dangerous position, inasmuch that if the commander depend on the appearance of the sea, as an indication of the proximity of a hurricane, he may here be greatly mistaken. The wind, its hauling and meteorological accompaniments, are sure indications of the presence of a cyclone; and it may be added, that *the absence of a cross sea* is also

an indication of the vessel being on the confines of the most dangerous octant.

Another vessel with the wind at N.W., experiences a mighty hubbub, she is involved in a turbulent pyramidal cross sea, and this is the greatest difficulty she has to encounter, the cyclone is leaving her in its wake, which is characterized on the starboard side, by a "heavy cross sea."

A third vessel experiences the easterly winds of a cyclone, free from a turbulent cross sea. As the wind veers to E.N.E. the cross sea overtakes her, and if she continue in the wake of the hurricane, she will still experience the cross sea, but not to the extent that a vessel in the starboard or opposite side of the wake will.

APPENDIX I.

EXAMINATIONS IN STEAM.

16. Arrangements have been made for giving to those Masters, or First or Only Mates who possess Certificates of Competency, or who may apply for such Certificates, and who desire it, an opportunity of undergoing an examination as to their practical knowledge of the use and working of the steam engine. These examinations will be conducted under the superintendance of the Local Marine Boards, at such times as they may appoint for the purpose; and the Examiners will be selected by the Board of Trade, from the Engineer Surveyors appointed under the Act.

The Examination will not comprise intricate theoretical questions, but will be such as to satisfy the Examiner that the applicant is competent to control the working of the engine, and has such a knowledge of the ordinary parts of the machinery, as will enable him to judge of the nature of an accident, and, in the absence of the engineer, to give the necessary directions in the engine room.

The practice will be as follows:—The applicant must deliver to the Shipping Master a statement in writing, to the effect that he wishes to be examined in Steam. If he is about to pass an examination in Navigation, the statement must be on or annexed to the form E E.: if the applicant has a certificate of Competency, the statement must be delivered to the Shipping Master with his Certificate, so that due notice may be given to the Examiner, and so that the Board of Trade on receiving it, may have the means of indorsing on

his Certificate and recording the fact that he has "*Passed in Steam.*" He must also, at the same time, pay a fee of £1, which will be applied in remunerating the Examiners.

Notice will be given of the time at which the applicant is to attend to be examined; and if he passes, the result of the examination will be reported to the Board of Trade, and his Certificate of Competency will be issued or returned to him, as the case may be, with an indorsement as above mentioned showing that he has "*Passed in Steam.*" If he fails, no notice of the failure will be recorded on the Certificate, but *no part of the fee will returned.*

17. Full directions as to the course of Examination in Steam, and the qualifications required of candidates, are contained in the instructions issued to Engineer Surveyors appointed as Examiners at the large Ports.

T. H. Farrer,
Secretary,

Naval Department, Board of Trade,
May, 1855.

QUESTIONS

To be answered by Commanders of Steam Vessels, under examination in the practical use of the Steam Engine.

Explain the nature and use of the principal valves and cocks connected with the boilers and engines, commencing with the boilers.

BOILER VALVES AND COCKS.

Safety valves,—to control the pressure of steam, and to allow the steam to pass off, after it reaches the required pressure.

Reverse or atmospheric valves—prevent the formation of vacuum, by allowing the air to pass into the boilers, and save them from collapsing, from external atmospheric pressure.

Communication or stop valves,—for communication between the boilers or between boiler and engine, so that they can be shut off from each other if necessary.

Feed valves,—regulate flow of water into boiler, and are fitted to the feed pipes to prevent the water from returning from the boilers.

Kingston's valves,—are conical valves fitted in the ship's side, at the end of blow off-pipe, to enable the cocks to be taken out if required, and can be closed if necessary.

Blow off cocks,—for blowing supersalted water out of boiler into the sea, they are fitted at the bottom of the boilers.

The water guage cocks,—for showing the height of water in boiler, in case of accident to the glasses or cocks.

The glass water guage,—for showing the same more easily.

Steam guage,—shows the pressure of steam, it is a bent pipe containing mercury, which rises one inch, to every increased pound of pressure.

Hand pump for boilers,—for filling them when the engines are stopped, or before lighting fires.

ENGINE VALVES AND COCKS.

Throttle valves,—are fitted in steam pipe, for shutting off and regulating steam to the cylinders.

Slide valve,—to admit steam to give the necessary motion to piston by shutting off and admitting steam to the cylinder and condenser.

Expansion valves,—are placed between the throttle and slide valves, for cutting off steam at any required part of the stroke, leaving the rest to be worked by expansion in the cylinder.

Escape valves,—for allowing the escape of water or too strong steam that may be in the cylinder.

Blow-through valves,—for forming a vacuum, in the cylinder on both sides of the piston, and in the condenser before starting.

Foot valve,— is at the bottom of air pump to prevent return of water into the condenser on the down stroke of the air pump bucket.

Delivering valve,—prevents return of water from hot well, it is at the top of the air pump.

Air pump bucket valve,—to allow the bucket to pass through the water in the air pump, after it has drawn it from the condenser, and before forcing it into the hot well: it opens in descending and closes in ascending.

Injection valves and cocks,—for regulating the flow or injection of water for condensing steam, the valve is fitted on the condenser, the cock on the ship's side

Bilge pump valves and cocks,—for pumping water out of bilge, the valves are fitted to the bilge pumps, and the cocks to the different bulkheads to be pumped from.

Stop or sluice valves,—to discharge pipes, for preventing any sea water entering the discharge pipe.

Jacket cocks, – for escape of water from slide jacket of the cylinder before starting.

The snifling valve,—allows a small quantity of air to enter the condenser and air pump to prevent concussion of valves.

BOILERS.

Q.—If the safety valves were set fast, how would you relieve the pressure on the boilers, if steam was up and could not make its escape?

A.—Keep engines full speed, blow off and feed, keep the blow-through valves and guage cocks both full open, shut the dampers, draw the fires and play the water hose on the engines.

Q.—How do you ascertain the saltness of the water in the boilers?
A.—By an instrument called the Salinometer.

Q.—How would you manage to change the water in the boilers, if the blow-off cocks were set fast?
A.—By blowing off by the deck pump sea cock, if there be one, or by taking the valves out of feed pump.

Q.—On examining the boilers, and they are found to be thin, what measures would you adopt to prevent accidents?
A.—Reduce the pressure on safety valve.

Q.—How would you keep the boiler free from salt and incrustation?
A.—By frequently blowing off.

Q.—Is it requisite to have a hand-pump fitted to the boilers; if so, for what purpose.
A.—Yes, to fill boilers when steam is not up, or in case of accident to feed pump.

Q.—Explain the use of the guage-glasses and guage-cocks, fitted on the boilers.
A.—To show height of water in boiler, the former at a glance; the latter by opening them.

Q.—If the mercury was blown out of the steam guage by the pressure of steam in the boilers; what would you apprehend was the cause?
A.—That the steam was dangerously high.

Q.—What would you do to relieve the pressure of the boilers.
A.—Open the furnace fire doors and shut the dampers and ease the safety valves.

Q.—How would you regulate the height or quantity of water in the boilers?
A.—By allowing the water to rise from a little above the middle of glass to near the top every watch.

Q.—When the steam is up, how is the feed applied to the boilers?
A.—By feed pump worked by engine, if in motion, otherwise by hand pump.

Q.—When it is not up, what is necessary to be done before the fires are lighted?
A.—Fill boilers

Q.—When the engines are stopped, what precautions are necessary with regard to the water in the boilers?

A.—Keep the proper quantity of water in the boiler.

Q.—What is meant by a boiler priming?
A.—When the water leaves the boiler with the steam.

Q.—How would you prevent it doing so?
A.—Reduce the pressure and keep the water low.

Q.—If the water in a boiler is suffered to get too low, what may be the consequences?
A.—The tubes or flues would be burnt.

Q.—What height should the water stand in a common boiler above the flues.
A.—About 10 inches.

Q.—What height should the water stand in a tubular boiler above the tubes?
A.—About 8 inches.

Q.—If any of the tubes were damaged by the fire, or leaky what would you do, supposing you could not shift them?
A.—Plug up both ends firmly with some metallic substance.

Q.—How do you detect the pressure of steam in a boiler?
A.—By the steam gauge.

Q.—If the water in a boiler is suffered to get too high, what might be the consequences?
A.—Water will pass out with the steam into the cylinder and perhaps knock the bottom out.

Q.—How would you know when the water in the boiler requires changing?
A.—By testing it with the Salinometer.

Q.—Explain the use of the thermometer and hydrometer?
A.—The thermometer shows heat either of steam or water. The hydrometer shows the density or saltness of water.

ENGINES.

Q.—Explain the use of the cylinders.
A.—To contain the steam while acting on or giving motion to the pistons.

Q.—Explain the use of the air pump.
A.—To form a vacuum in the condenser and draw the exhausted steam from the cylinder.

Q.—Explain the use of the condenser.
A.—For condensing the steam after leaving the cylinder.

Q.—Explain the use of the eduction pipe.
A.—Por conveying steam from the cylinder to the condenser

Q.—Explain the use of the hot-water cistern.

A.—To receive water from the air pump for feeding boiler.

Q.—Explain the use of the piston, and how fitted.

A.—The piston is made to move steam-tight upwards and downwards in the cylinder, giving motion to the machinery, and is acted upon by the steam according as admitted by slide valve; it is fitted with packing, generally metallic, and is kept close to the interior surface of the cylinders by springs; a junk ring is used to keep the packing in its place.

Q.—Explain the use of the stuffing box and glands.

A.—The stuffing box contains packing to keep the piston air tight, and the glands keep the packing in its place.

Q.—Explain the use of the parallel-motion rods.

A.—For a guide for the piston rod, keeping them parallel to the inside of the cylinder.

Q.—Explain the use of the Excentric, and how fitted.

A.—To open and shut the slide valves at the proper time, and is fitted with an excentric wheel, loose on the shaft, with a stop at a certain point for going a-head or reversing,; the rod is fitted with apparatus for throwing it out of gear.

Q.—Explain the use of the starting lever.

A.—For moving the slide valves by hand when necessary to start or reverse the engines before the excentric is set into gear.

Q.—Explain the use of the barometer.

A.—To indicate the heat of the steam.

Q.—Explain the use of the steam guage.

A.—To show the pressure of steam in the boiler.

Q.—The vessel is alongside the wharf, proceed to get the steam up.

A.—Put the necessary quantity of water in the boilers and light the fires.

Q.—When the steam is up, how is it applied to the engines to set it in motion?

A.—Open the throttle valve and place the slide valve in the proper position.

Q.—What precaution is necessary before the engine is set in motion?

A.—To admit the steam into the cylinder on both sides of the piston, and to clear out the water.

Q.—How do you start the engine?

A.—Place the slide valve in the required position and open the throttle valve and injection cock.

Q.—Is it necessary to move the engine by hand a turn or two before starting?

A.—Yes, to force out the condensed steam.

Q.—The engines being started, regulate the injection-cocks, so as to keep them going at full or reduced speed.

A —Open the injection cock until the waste water pipe is cool to the touch; the temperature of the condenser should be from 100° to 120°.

Q.—What is the use of the injection?

A.—To condense the steam which has left the cylinders.

Q.—How is the vacuum maintained in a condensing engine?

A.—By the air pump.

Q.—How do you know when there is too much injection?

A,—By irregular working of air pump, causing a bad vacuum in condenser.

Q.—How do you know when there is not enough injection?

A.—When the condenser is hot.

Q.—If the injection was not shut off when the engines are stopped, what would happen.

A. The condenser would fill with water, and it would be very difficult to start the engine when required.

Q.—If the condenser reject the injection, what would you do?

A.—Turn on bilge injection or drill a hole in condenser and apply water through the hole.

Q.—Would it be advantageous if an injection-pipe was fitted so as to take injection from the bilge, if required?

A.—Yes, in case of the ship springing a leak.

Q.—If water should get into the cylinder, what might be the consequences?

A.—It might break the cylinder, piston, or cover.

Q.—In running free with a heavy sea, and a jump upon the engines, what precautions would you take to endeavour to prevent damage to the engines?

A.—Partially close the throttle valve each time the vessel rolls heavily.

Q.—If one engine was damaged, what would you do in order to proceed?

A.—Disconnect the damaged one and go on with the other.

Q.—If the excentric should break, could the engines still be worked?

A·—Yes, in some instances by hand.

Q.—If a bearing becomes heated, what would you do?

A.—Slack the nuts, ease the engines, pour melted tallow and sulphur on it, nearly cold water may be carefully poured on the heated part.

Q.—How would you slow an engine?

A.—By partially closing the throttle valves and injection cocks.

Q.—How would you stop an engine?

A.—By throwing the excentric out of gear, and shutting the throttle valves.

Q.—Wherein does a high-pressure differ from a low-pressure engine?

A.—In high-pressure engines there is no condenser or air pump, the steam is dicharged from the cylinder. In low-pressure engines it passes into the condenser.

Q.—How do you admit tallow into the cylinders, when the engines are at work, for the purpose lubricating the pistons?

A.—By opening the grease cock on the cylinder while the piston is ascending, and closing it on the down stroke of the piston.

Q.—What is meant by working the engines expansively?

A.—Closing the throttle valve at any part of the stroke, leaving the rest to be done by expansion in the cylinder.

Q.—How would you disconnect the engines if there was no disconnecting gear fitted?

A.—By taking the bolts out of the connecting rod cap.

Q.—What is meant by throwing the engines out of gear?

A.—Disconnecting the excentric from the slide valve.

Q.—Why have two feed-pumps fitted, say one to each engine?

A.—In case of one engine breaking down, the feed may be supplied by the other,

Q.—Is it requisite to have branch-pipes fitted to the feed-pumps; if so, for what purpose?

A.—Yes, for escape of water when not required, and for passing water on deck if necessary.

The Engineer Examiner should provide drawings and working sections, on a sufficiently large scale, of the various parts of the steam engine, and of the valves and slides, &c. as may be necessary, and should require the applicant to make use of them in giving his answers to the various questions put to him; and, if an opportunity offer, the applicant should be permitted, under the guidance of the Engineer, to start and stop an engine of some vessel which may have her steam up.

N.B.—Lardner "on the Steam Engine," and Murray "on the Marine Engine," two books published in Weale's Rudimentary Treatises, give considerable information, in a very concise manner, on the foregoing Questions; but it must be borne in mind, that a practical knowledge of the Steam Engine will alone enable the Candidate to enter into all the details to the satisfaction of the Examiners; this practical knowledge can only be acquired by spending a short time in an Engineer's Workshop, or on board one of the numerous Steamers of our Coast.

It is advisable that all candidates for examination in steam, should have before them a drawing showing the Motional, and other parts of the steam engine; the Examining Engineer allows the use of such assistance, as it helps the memory.

These Answers to the Questions on Steam, have been supplied by an experienced working Engineer, who will, on moderate terms, give instruction on the Steam Engine, to Candidates for this Examination; he has Working Models which will greatly aid the pupil in obtaining a knowledge of the Marine Steam Engine.

APPENDIX II.

Answers to Miscellaneous Questions in Arithmetic, p. 22.

1. 10,010,010,
2. 33972
3. 845544960 inches
4. 90660004
5. 909,040
6. 239590
7. 311592960 ounces
8. 60704090
9. 104,090,009
10. 185627
11. 12934753920 barleycorns
12. 82090007
13. 90.204,050
14. 1029875
15. 25485917760000 seconds
16. 807098000
17. 100.060,409
18. 760715
19. 48777442560 inches
20. 6409010178
21. 900,002,001
22. 1005721
23. 8793360000″
24. 2000007
25. £2912 14*s* 3½*d*.
26. ·75 = ¾
27. £3635 2*s*.

Answers to the Exercises in Logarithms, &c. pp. 25. 26.

1.	3·829561	3·857332	4·640581	4·601038	5·602060
	$\bar{1}$·165244	$\bar{3}$·810904	0·588160	1·255417	$\bar{3}$·662758
2.	5·8672+	6·6308+	237·08+	407 78+	10016·37
	74·854+	82·035+	1259·7+	1639·8+	100340·4+

3. sine	9·867731	9·217122	8·504198
	9·978387	9·972463	8·246654
cosine	9·907282	8·361681	8·246773
	9·972585	9·937470	9.505271
tangent	9·613707	8·297036	10·109995
	9·879657	8·258262	10·348195
4. cotangent	10·094133	9·783450	9·518992
	9·684753	10·793269	11·263849
secant	10·028424	10·151822	10·503501
	10·059001	10·714158	10·104167
cosecant	10·149446	10·025635	10·203770
	10·100598	10·061659	10·559516

APPENDIX II.

5.

8°	43′	6″	78°	8′	50″	1°	39′	39″	4°	1′	28″
77	14	19	15	31	22	41	12	21	84	40	38
23	43	17	81	53	25	35	3	31	48	58	24
61	3	33	7	34	15	76	40	15	88	20	53
22	35	46	35	39	40	88	22	22	86	22	56
50	57	26	60	13	52	1	57	4	5	43	39

6. 300

7. 4500

8. 6309

9. 2148

10. 7000

11. 324632

12. ·23105 +

13. 479·87 +

14. 3·8293 +

15. ·036902 +

16. 22

17. 70·6363 +

18. 12

19. 1

20. 10

21. 240·29 +

22. 1850

23. ·086956 +

24. 1·70648 +

25. 884403·6 +

26. ·129996

27. 2116   8836   ·026569   00005625

28. 103823   250047   001295 +   0000006382 +

29. 69·253   864·25 +   ·80436 +

30. 33·163   39·611 +   ·91113

31. £113. 2*s*. 11¼*d*.

32. £225. 18*s*.

33. 4*s*. 8½*d* $\frac{2}{5}$

34. £7. 10*s*. 1½d. $\frac{6}{35}$

Answers to the Days Works, pp. 27—30.

1.	Diff. lat. 54·3′S.	: dep, 31·4′E.	: Course S. 30° E. dist. 63′
	Lat in 35° 45′S.	: diff. long. 39′E.	: Long. in 20° 41′E.
2.	Diff. lat. 19′S.	: dep. 57·5′W.	: Course S. 71¾°W. dist. 61·5′
	Lat. in 40° 10′N.	: diff. long. 1° 15′W.	: Long. in 125° 47′W.
3.	Diff. lat. 128·5′S.	: dep. 11·8′E.	: Course S. 5°E. dist. 129′
	Lat. in 27° 48′S.	: diff. long. 13′E.	: Long. in 45° 15′E.
4.	Diff. lat. 22·6′S.	: dep. 3·3′E.	: Course S. 8°E. dist. 23′
	Lat. in 37° 58′S.	: diff. long. 4′E.	: Long. in 150° 9′E.
5.	Diff. lat. 60·8′S.	: dep. 66·8′W.	: Course S 48° W. dist. 91′
	Lat. in. 3° 23′N.	: diff. long. 67′ W.	: Long. in 8° 53′W.
6.	Diff. lat. 25·9′N.	: dep. 16·4′W.	: Course N. 33°W. dist. 31′
	Lat. in 34°S.	: diff. long. 20′W.	: Long. in 172° 18°E.
7.	Diff lat. 31·2′S.	: dep. 10·7′E.	: Course S. 19°E. dist. 33′
	Lat. in 26° 10′S.	: diff. long. 12′E.	: Long in 45° 19′E.
8.	Diff. lat. 13·2′	: dep. 38·4	: Course S. 69½°E. dist 41′
	Lat. in. 53°55′N	: diff. long. 1° 5′E.	: Long. in 179° 49′W.

Answers to the Exercises for the Ordinary Examination.

PAPER I.—p 36.

1. 3268.
2. 36.
3. Diff. long. 155′
4. Dec. 17° 54′ 37″ S. Lat. 48° 31′ 59″ S.
5. Course N. 56° 10′ W Dist. 6618 miles.
6. A. T. G. 6d 3h 23m. Dec. 22° 27′ 10″. True ampl. E. 29° 2′S
   Variation 9° 21′ E.
7. 10h. 23m. a. m. 11h. 0m. p. m.
8. M. T. G. 6d. 13h. 15m. 30s. Dec. 22° 24′ 4″S. True azimuth.
   S. 90° 14′ W. Variation 11° 29′ E.
9. M. T. G. 30d. 1h. 53m 30s. Dec. 17° 33′ 23″S. Eq. T. 13m. 39s.
   A. T. S 30d. 4h. 33m. 59s Long. 43° 32′E.
10. A. T. S. 5d. 17h 46m. 40s. Dec. 22° 30′ 4″S. zen. dist 31° 25′ 27″N,
    Lat. 8° 55′ 23″N.
11. N. 55°E, S. 71° 30′ E, S. 17° 30′W, N. 10° 5′W, N. 78° 10′E.
12. Lat. 36° 0′ 19″N.

PAPER II.—p. 37.

1. 5123
2. 2.
3. Diff. long. 132′
4. Dec. 8° 56′ 16″S. Lat. 37° 55′ 10″N.
5. Course S. 73° 24′W. Dist. 2559 miles.
6. A.T.G. 13d 23h 15m 20s. Dec. 12° 55′ 20″ True amplitude, W. 13° 46½°S. Variation 2° 31½′W.
7. 9h 5m a m. 9h 20m p. m.
8. M.T.G. 15d 10h 35m 18s. Dec. 12° 25′ 10″S. True azimuth, S. 64° 34′E. Variation 4° 41′E.
9. M.T.G. 14d 22h 57m 40s Dec. 12° 35′ 14″S. Eq. time 14m 25s. A.T.S. 20h 42m 6s Long. 30° 17′ 15″W.
10. T. from noon 24m 58s. Dec. 9h 20m 23s. S. Lat. 57° 56′ 13″S.
11. S. 81° 10′E. S. 61° 55′E. N. 24° 10′W. S. 59°40′W. S. 3°E.
12. Lat. 47° 26′ 41″S.

PAPER III. —p. 38.

1. 6354
2. 12
3. Diff. long 102′
4. Dec. 11′ 30″N. Lat. 22° 53′ 52″N.
5. Course S. 43° 38′E. Dist. 6514 miles.
6. A.T.G. 5d 3h 14m. Dec. 5° 52′ 59″S. True amplitude. E. 7° 49′S. Variation 16° 15′E.
7. 8h 38m a.m. 9h 26m p.m.
8. M.T.G. 23h 14m 50s Dec. 2° 25′ 42″ True azimuth, N. 90° 18′W. Variation 6° 33′W.
9. M.T.G 24d 1h 30m 15s Dec. 1° 33′ 19″N. Eq. time 6m 20s A.T.S. 3h 56m 59s Long. 38° 16′E.
10. T. from noon 21m 44s Dec. 45′ 21″N. Lat. 43° 16′ 48″N.
11. S. 86° 15′E. S. 66° 42½′ N. 10° 5′W. S. 48° 48′W.
12. Lat. 57° 33′ 25″N.

PAPER IV.—p. 39.

1. 12036
2. 110
3. Diff. long. 98′
4. Dec. 6° 58′ 27″N. Lat. 58° 47′ 23″N.
5. Course N. 66° 15′ W. Dist. 3153 miles
6. A.T.G. 12d 22h 20m 52s. Dec. 9° 7′ 15″N. True amplitude. W. 9° 44′N. Variation 1° 18′E.
7. 14h 49m a.m. 3h 28m p.m.
8. M.T.G. 15d 1h 25m 16s Dec. 9° 53′ 7″N True azimuth, S. 90° 52′ E. Variation 8° 38′E.
9. M.T.G. 15d 22h 44m 20s Dec. 10° 12′ 3″N. Eq. time 15s. A.T.S. 3h 19m 25s Long. 68° 42′ 30″E.
10. T. from noon 28m 52s Dec. 13° 35′ 35″N. Lat. 29° 8′ 55″
11. S. 38°W. N. 49° 50′W. N. 74° 20′W. S. 3°E.
12. Lat. 20° 56′ 33″S.

PAPER V.—p. 40.

1. 1404·2
2. 3·64545
3. Diff. long. 167′
4. Dec. 22° 48′ 35″N. Lat. 34° 49′ 43″S.
5. Course N. 63° 59′E. Dist. 6935 miles.
6. A.T.G. 18d 2h 9m 40s. Dec. 20° 59′ 29″N. True amplitude, E. 35° 1′N. Variation 4° 21′E.
7. 6h 24m a.m. 6h 43m p.m.
8. M.T.G. 10d 2h 8m 2s. Dec. 22° 13′ 2″N. True azimuth, 44° 40′ N.E. Variation 15° 0′ E.
9. M.T.G. 16d 2h 44m 40s. Dec. 21° 19′ 51″N. Eq. time 5m 44s. A.T.S. 19h 45m 24s Long. 103° 23′ W.
10. T. from noon 25m 20s Dec. 19° 38′ 18″N. Lat. 43° 41′ 42″S.
11. S. 81° 10′W. N. 67° 10′E. S. 48° 48′W. N. 78° 10′E.
12. Lat. 35° 57′ 48″S.

PAPER VI —p. 41.

1. 12·224
2. 28·966
3. Diff. Long. 141.
4. Dec. 20′ 15″S. Lat. 41° 29′ 37″N.
5. Course S. 57° 13′E. Dist. 5941 miles.
6. A.T.S 30d 21h 55m 30s Dec. 3° 14′ 56″S. True amplitude E. 4° 23′S. Var. 4° 3′W.
7. 2h 25m a. m. 2h 49m p. m.
8. M T. G. 1d 1h 52m 14s Dec. 3° 18′ 59″S. True azimuth N. 89° 8′W Variation 18° 23′W.
9. M.T.G. 26d 7h 54m Dec. 12° 41′ 30″S. Eq. time 15m 59s A.T S. 25d 20h 31m 38s Long. 174° 35′ 15″W.
10. A.T.G. 29d 1h 20m 12s Dec. 13° 34′ 13″S. zen dist. 58° 32 26″N. Lat. 44° 58′ 13″N.
11. S. 70° 25′W. S. 6° 55′E, S. 66° 42½′E. N. 55° 52½′W.
12. Lat. 9° 48′ 26″S.

PAPER VII.—p. 42

1. ·05445
2. ·1205
3. 210·6 Diff. long.
4. Dec. 12′ 2″S. Lat. 32° 39′ 10″S.
5. N. 69° 59′ E. Dist. 3790 miles.
6. A. T. G. 15d 16h 19m Dec. 23° 19′ 56″S. True amplitude E. 31° 10′ S. Var. 11° 1′W.
7. 2h 50m a.m. 3h 8m p.m.
8. M.T.G. 16d 1h 11m Dec. 23° 20′ 55″S. True azimuth S. 57° 20′E. Variation 8° 50′E.
9. M.T.G. 24d 17h 9m Dec. 23° 24′ 42″S. Eq. time 18s. A.T.S. 2h 56m 11s Long. 146° 52′ 15″E.
10. A.T.G. 12d 22h 39m Dec 23° 10′ 58″S. zenith dist. 39° 23′ 29″S. Lat. 62° 34′ 27″S.
11. S. 76° 20′E. N. 61° 5′E. N. 23° 6′E. N. 24° 10′ W.
12. Lat. 30° 2′ 47″S.

APPENDIX III.

Answers to the Exercises for the Extra Examination.

PAPER I—p. 88.

1. ☾'s hor. par. 54′ 50″ : ☾'s dec. 5° 53′ 48″S. : Lat. 23° 29′ 43″N. 1st cor.
2. Sid. T. obs. 3h 6m 25s : —1° 14′ 46″ : 2nd cor. + 16″ : 3rd cor + 1′ 23″ Lat. 43° 51′ 11″
3. ☉'s dec. at mid. time 17° 25′ : Lat. 26° 12′ 20″N.
4. Lat. 26° 12′ 50″N.—assuming 25° 51′ and 26° 31′
5. Eq. of equal parts. —6·4s : chron. fast on app. T. 1h 3m 2·6s and fast on M.T.S. 50m 43·6s.
6. Hor. par. 55′ 16″ : true dist. 30° 45′ 43″ : M.T.G. 13d 6h 20m 42s Long. 32° 12′W.
7. True alt. 43° 14′ 46″.
8. Set of 18′ : N. 77½°E.

PAPER II.—p. 89.

1. ☾'s hor. par. 56′ 28″ : ☾'s dec. 25° 45′ 53″N. : Lat. 65° 30′N.
2. Sid. T. obs. 7h 10m 25s : 1st cor. + 54″ : 2nd cor. + 1′ 30″ : 3rd cor + 1′ 7″ : Lat. 54° 49′ 41″.
3. ☉'s dec. at mid. time 4° 52′ 16″ : Lat. 30°N.
4. Lat. 30° 1′ 30″N. — assuming lat. 29° 42′ and 30° 22′
5. Eq. of equal parts 2·6s : chron. fast on App. T. 6h 35m 37·4s and 6h 35m 42·4s fast on M. T.S.
6. Hor. par. 55′ 54″ : true dist. 105° 1′ 12″ : M.T.G. 20h 4m : Long. 109° 17′ 30″E.
7. True alt. 30° 51′ 12″
8. S. 71°W. 91 miles

PAPER III.—p. 90.

1. ☾'s hor. par. 55′ 40″ : ☾'s dec. 24° 50′ 46″N : Lat. 25° 30′ 24″S.
2. Sid. T. obs. 14h 35m 57s : 1st cor. +1° 19′ 50″ : 2nd cor. + 13″ 3rd cor. + 48″ : Lat. 51° 12′ 23″.
3. ☉'s dec. at. mid. time 21° 33′ 20″ : Lat. 3° 33′ 50″N.
4. Lat. 3° 34′N.—assuming lats. 3° 18′ and 3° 48′
5. Eq. of equal parts 6·1. chron. fast on App. time 1h 58m 56s and 2h 2m 48s. on M. T. S.
6. Hor. par. 57′ 51″ : true dist. 40° 5′ 37″ : M. T G. 53′ 36″ Long.
7. True alt. 49° 7′ 40″
8. S. 79° W. 60 miles.

PAPER IV.—p. 91.

1. ☾'s hor. par. 58′ 36″ : ☾'s dec. 24° 30′ 36″S. : Lat. 55° 49′ 5″S.
2. Sid. T. obs. 19h 8m 18s : 1st cor. + 1′ 51″ : 2nd cor. + 1′ 9″ : Lat. 60° 55′ 14″
3. ☉'s dec. at M. T. 22° 59′ 45″ Lat. 10° 12′ 34″N.
4. Lat. 10° 13′ 14″N.
5. Eq. of equal alt. + 6·1s : Chron. slow on A.T. 1h 24m 24s and on M.T.S. 1h 30m 6s
6. ☾'s hor. par. 59′ 36″ : A.T.S. 7h 2m 12s : ☾'s R. A. 12h 21m 29s : ☾'s dec. 7° 57′ 13″S. . ☾'s true alt. 30° 0′ 34″ : true dist. 111° 27′ 26″ : M. T. G. 20h 15m on the 9th.
7. True alt. 49° 4′ 25″
8. N. 65°E. 93 miles

PAPER V.—p. 92.

1. ☾'s hor. par. 58′ 4″ : ☾'s dec. 24° 31′ 8″S. : Lat. 63° 41′ 17″S.
2. Sid. T. of obs. 1h 50m 58s : 1st cor. —1° 24′ 30″ : 2nd cor. +3″. 3rd cor. +1′ 20″ : Lat. 52° 31′ 32″
3. ☉'s dec. at mid. time 13° 39′ 10″ : Lat·40° 41′ 12″S.
4. Lat. 40° 39′ 30″S.
5. Eq. of equal alt. 9s. : chron slow on A.T.S. 2h 34m 9s and 2h 23m 6s on M. T. S.
6. ☾'s hor. par. 59′ 11″ : M. T. S. 4h 16m 16s. : ☾'s R. A. 16h 19m 12s : ☾'s dec 24° 18′ 54″ : ☾'s A. alt. 16° 9′ 5″ : True dist. 79° 12′ 58″ : M. T. G. 1d 5h 18m 5s : Long. 15° 27′ 15″W.
7. True alt. 32° 51′ 3″
8. N. 35°W. 107 miles.

PAPER VI.—p. 93.

1. ☾'s hor. par. 54′ 39″ : ☾'s dec. 7° 3′ 2″N. : Lat. 6° 52′ 50″S.
2. Sid. T. obs. 2h 48m 20s : 1st cor. —1° 17′ 53″ : 2nd cor. +18″ : 3rd cor. +1′ 31″ : Lat. 54° 57′ 31″
3. ☉'s dec. at mid. time 23° 6′ 15″ : Lat. 52° 26′ 30″S.
4. Lat. 52° 25′ 18″S.
5. Eq. of equal alt. 5·7s. : chron. slow on A. T. S. 2h 38m 10·3s and on M. T. S. 2h 30m 38·3s
6. ☾'s hor. par. 54′ 18″ : true dist. 106° 20′ 11″ : M.T.G. 13h 14m 20s Long. 37° 11′ 15″E.
7. True alt 40° 7′ 48″
8. S. 6°W. 64 miles

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